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ABSTRACT

A two-tier intervention study was designed to provide descriptive models of constructivist learning environments supported by appropriate technology, as they emerged in project classroom. Tier 1 was a collective case study of approximately 150 classrooms in 5 southwestern states whose teachers received training in applying technology. Tier 2 consisted of detailed case studies of six teachers and how they created constructivist learning environments. The project focused on classrooms with high populations of traditionally underserved students, including economically disadvantaged, linguistically diverse, rural, American Indian, and Mexican American students. The intervention consisted of assistance to participating teachers in technology planning, professional development, and follow-up assistance and support. Findings indicate that (1) while teachers with only one computer can and did change their practice, that change was minimal compared with that observed in classrooms with more computers; (2) knowing how computer technology can be used to enhance learning and being able to plan effective learning activities were more important than having strong personal computer skills; (3) professional development that engaged teachers as learners and modeled the integration of technology with learner-centered approaches enabled many teachers to implement technology and constructivism concurrently; (4) rather than a single model, a range of constructivist practices supported by technology emerged; (5) more change in teaching practice and technology use occurred at sites where more teachers participated; and (6) the change process varied with different teachers. Appendices present an overview of the case studies, the six case studies, case study interview questions, and other research materials. (TD)

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Applying Technology to Restructuring and Learning

Final Research Report
December 2000

Technology Assistance Program

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Overview

Purpose

The *Applying Technology to Restructuring and Learning (ATRL)* project was designed to provide descriptive models of constructivist learning environments supported by appropriate technology as they emerged in classrooms over the course of the project.

The research component of this project involved an *intervention study* with a two-tiered research design. *Tier One* was a collective case study of the approximately 150 classrooms, located across six school sites, whose teachers participated in 72 hours of ATRL professional development. *Tier Two* consisted of six detailed case studies of individual teachers whose experiences represented the process and the practices they employed in creating a constructivist learning environment within their classrooms. The project focused particularly on classrooms in schools with high populations of traditionally underserved students. The intervention consisted of assistance in three areas: planning assistance, professional development for participating teachers (six sessions in each of the two years of the intervention), and follow-up assistance and support. The study employed a qualitative strategy to answer the research questions, although both quantitative and qualitative data were collected and analyzed. The study as a whole was grounded in an interpretivist paradigm with the goal of "understanding the complex world of lived experiences from the point of view of those who live it" (Schwandt, 1994, p. 118).

Research Questions

Three broad questions guided the research study and created a framework for investigation and analysis:

1. What do constructivist learning environments look like in practice, particularly in classrooms with high populations of culturally and linguistically diverse students?

   Note: *The particular social context of the study sites created the framework for this study. Therefore, the term "high populations of culturally and linguistically diverse students" serves only as a description of students who attended the classrooms in this study. Some of the study sites had over 95% of the same cultural and linguistic group within that site, therefore offering little cultural or linguistic diversity within the site. The intent of the study was not to make comparisons across the sites but rather examine what occurred in classrooms at these sites. The reader is referred to the descriptions of each site's demographics on pages 8 & 9 of this document.*

2. How can teachers be assisted in developing constructivist learning environments supported by technology?
   What school context issues or teacher qualities influence this development and what role does professional development play in bringing about this development?

3. How does technology facilitate the development of a constructivist learning environment?
   How do teachers use technology and how does technology allow or promote a change in the way they teach?

Definitions

Definitions for key terms used in the study were established strictly for the purposes of the ATRL project and its research design:

Constructivism was defined as a learning theory that "proposes that knowledge or meaning is not fixed. . . but rather is constructed by individuals through their experience. . . in a particular context" (Honebein, Duffy, & Fishman, 1991).

A *constructivist learning environment* (CLE) was defined as a classroom in which "instruction is more a matter of nurturing the ongoing processes whereby learners ordinarily and naturally come to understand the world in which they live" (Knuth & Cunningham, 1991, p. 164). ATRL staff worked to identify observable characteristics of a technology-assisted constructivist learning environment. These characteristics were drawn from constructivist principles (listed on pages 3-4) and were incorporated into the observation protocol (Appendix 9) which was used in the research study for observation and analysis purposes.

Technology was defined as computers, whether alone or in combination with other hardware, software, or networks.

The Intervention

The purpose of the intervention was to assist and support participant teachers in creating technology-assisted constructivist learning environments. ATRL project staff[1] provided assistance in three areas vital to the creation of these learning environments: planning, professional development, and follow-up assistance and support.

Planning. Planning for professional development time was of utmost importance as it required, in some sites, coordination with the district's annual schedule or early dismissal days to accommodate the six days of professional development for each of the two school years. Other planning included suggestions for the purchase of appropriate software applications, designing and developing appropriate activities for the site

[1] ATRL project staff performed a variety of roles – technology consultant, researcher, designer, developer, and professional development facilitator.

teachers, finding and scheduling available physical space, and identifying other resources and needs.

One of the prerequisites for site participation was that each school district have a technology plan in place, have computers in place for teachers to use, and have onsite support for participant teacher. At some sites, ATRL staff participated in the decision making for the school or school district in regard to these matters. At all school sites, ATRL staff gave input on hardware, software, and resource allocation and organization.

ATRL staff was able to provide further assistance with the *Putting Technology into the Classroom: A Guide for Rural Decision-Makers* (Boethel, Hatch & Dimock, 1999). This document provides a "jump-start" for school administrators who are just beginning to think about technology acquisition and integration.

Professional development. Design and delivery of 36 hours of professional development each year (72 hours total) was carried out over the two years of the project. A co-developer was identified at each site and functioned either as a key informant at that site or as an assistant in the delivery of the professional development modules. Sessions were designed to be highly interactive and to model the application of constructivist learning theory. Guided reflection was used to scaffold teachers' construction of knowledge about new roles and practices. In addition, part of each session was allocated for teachers to share classroom activities they designed as they began applying constructivist approaches in the classroom. Major emphasis was devoted to teachers' own prior knowledge about how students learn. Instructional strategies included inquiry, project-based teaching, authentic learning and problem-based learning. Sessions used various types of software that supported student-centered learning and focused on teachers' ideas for other ways of using these software applications. Teachers analyzed and developed lesson plans and curriculum units in light of the characteristics of constructivist learning environments and each session modeled a management strategy for organizing a classroom for technology.

Establishing a theoretical framework. Constructivist learning principles were the anchor for developing the ATRL professional development sessions. However, during the initial planning stages it became apparent that project staff members held differing views of constructivist learning theory, how it played out in a classroom, and how technology supported the construction of knowledge.

While "constructivism is not a theory about teaching but is a theory about knowledge and learning" (Brooks and Brooks, 1993, p.vii) it was important for the project team to develop a framework for understanding and exploring the implications of this theory for teaching. Over the course of several weeks, the ATRL project team reviewed the literature (e.g. Brown, Collins & Duguid, 1989; Duffy & Jonassen, 1992; Brooks & Brooks, 1993; Duffy & Cunningham, 1996; Jonassen, 1996; Maddux et al, 1997) and arrived at a common understanding which resulted in the following six principles of constructivism. The following principles become the foundation for the ATRL project and were used for developing and carrying out each of the professional development sessions.

- Learners bring unique prior knowledge, experience, and beliefs to a learning situation.
- Knowledge is constructed uniquely and individually, in multiple ways, through a variety of authentic tools, resources, experiences, and contexts.
- Learning is both an active and reflective process.
- Learning is a developmental process of accommodation, assimilation, or rejection to construct new conceptual structures, meaningful representations, or new mental models.
- Social interaction introduces multiple perspectives through reflection, collaboration, negotiation, and shared meaning.
- Learning is internally controlled and mediated by the learner.

By developing and sharing these common ideas of how learning occurs, the ATRL team was able to create relevant and engaging learning experiences in professional development sessions that promoted collaboration and learner-centered activities.

Design and development issues. The design and development of the professional development sessions for the ATRL project evolved over a period of several months and strove to accommodate the unique characteristics of the teachers as well as their individual schools, a variety of computer skill levels, different learning styles, curriculum interests, and varying available hardware and software.

Because the project team's goal was to model authentic learning environments in its professional development sessions, it created activities that used limited numbers of computers rather than having a computer available for every participant. The logic was to help teachers learn to manage limited resources instead of becoming an "expert" in any single computer application. This approach fit the team's belief that learning is enhanced in authentic situations, promoted through collaboration, and is learner-centered rather than instructor-centered.

Classroom management models. In response to the design and development issues the ATRL team developed classroom models of technology management that did not require a lab setting to teach technology-rich activities. These models were designed so that teachers could replicate them in their classrooms. These models employed a grouping strategy and are described below.

The Active Learning Environments model was designed with a thematic focus of "Your Community." The facilitator presented the activity and then functioned as a "consultant" for the remainder of the activity. With the goal of the project explained, teams of four to five rotated through three different "learning stations" to gather data and information about their community. One station used a digital camera to gather images, another station used a simple electronic spreadsheet to analyze data, and a third station used printed materials about the community. Each of the stations had roles for each of the team members as well as instructions for completing the tasks at that station.

The Navigator Model was another group approach designed by the ATRL team. This model was more technology intensive than the Active Learning Environments model. It

was designed so participants could learn to use a software application while learning a new educational concept. Several teams of four were given a different part of a concept to explore within their team. To do this, they were asked to create a "concept-map" using concept-mapping software. While the team carried out its initial discussion, one person from each team attended "Navigator" training. Navigators were those teachers with medium to high computer skills and were selected in advance for that role. The facilitator spent approximately fifteen to twenty minutes with the Navigators teaching them the basics of the concept-mapping software. Once they were trained, the Navigators returned to their team. They then instructed the rest of the team on how to use the software. The Navigator had to abide by one specific rule: they could only give instruction and could not touch the keyboard. The rest of the team rotated using the keyboard so that everyone had a chance to use the software.

The Facilitator or Expert Model was designed to accommodate different skill levels of the participants. The facilitator/expert was a person who had some experience in the software and showed novice users ("students") how to use the software application. The facilitator/expert could not touch the mouse or keyboard. Each group had its own facilitator/expert and the role did not rotate within the group. This model was useful for carrying out more complex projects that required different skill sets and levels of expertise. The facilitator/expert was not necessarily the team leader. When ATRL staff carried out this staff development session, it pre-assigned teams and distributed the technology skilled teachers across all of the teams with the designation that they would be the technology facilitator/expert for that team.

Other models for managing technology in the classroom were also used throughout the professional development sessions. Most prominent was a collaborative grouping model in which all team members were responsible for creating a part of the final product. Other models included individual work, working in pairs, and working in groups of three or more. In all cases, participants discussed the advantages and disadvantages of the different management models and also the appropriate uses of each model in their classrooms.

During the development process, each module in the professional development series was first field tested with technology-using teachers who were also deemed as constructivist teachers and then modified according to their suggestions. The modules were then delivered to the project teachers who made further suggestions for improvement.

Over the two years of the project, sixteen modules were developed and were then incorporated into a professional development portfolio. Each module in the series exemplified instructional strategies that reflected a constructivist learning environment, included a link to computers through hands-on experiences, linked to curriculum competencies, and provided collaboration among participants and small group and/or whole group reflections. Each of the sixteen staff development modules was characterized by the following:

1. Took into account teachers' understanding and beliefs about how students learn,
2. Was supported by constructivist learning theory, both in terms of instructional approaches and the type of activity in which the learner engages,

3. Utilized inquiry, problem-based teaching and learning,
4. Uses commonly available software found in classroom settings,
5. Included two or more instructional strategies for managing a constructivist learning environment supported by limited amounts of technology; and
6. Asked teachers to judge how the different instructional strategies could be applied to their own classroom setting.

While many of the 150 teachers in the six project site schools for the ATRL project later reported that they initially expected technology-skills training, they instead received a much richer technology curriculum-integration learning experience through a variety of active learning environments. Computer skills were learned in context through meaningful authentic learning experiences and greater control was placed in the hand of the learner.

An analysis of many technology training curriculums for classroom teachers reveals that technology skills training is frequently the primary focus with little or no emphasis on managing technology use (Sun, Heath, Byrom, Phlegar, & Dimock, 2000). However, ATRL teachers participated in technology management models that they could take back and use in their classrooms.

Follow-up assistance and support. Two major categories of follow-up assistance were provided to participant teachers and school administrators. First, over the course of two years, project staff made regular follow-up visits to each participating site school in addition to the visits for professional development sessions. During these additional visits, staff observed participant teachers' classrooms, consulted with teachers individually and in small groups, and provided feedback, resources, technical support, and information based on teachers' concerns and needs. The ATRL staff also provided ongoing interactive assistance from a distance via the project's web site, e-mail interaction, and telephone conversations.

Second, the ATRL staff developed a variety of materials that were designed to aid teachers in creating constructivist learning environments supported by technology. This portfolio of materials included:

- *Connecting Students, Learning and Technology* — This practitioner paper was designed to offer teachers practical information on getting started with technology and student-centered practices.
- *Planning into Practice: Implementing and Integrating Instructional Technology*— Developed in collaboration with the Southeast and Islands Regional Technology in Education Consortia, this document assists school planning teams in their efforts to implement technology to improve teaching and learning. It helps teams to move from vision to goals to action.
- *Constructing Knowledge with Technology: A Review of the Literature*—This paper discusses the tenets of constructivist learning theory in light of its role in education and use with technology.
- *The ATRL web site*—<http://www.sedl/tap/resources.html> This is an online database of web resources for teachers. Teachers can search by more than a dozen subject areas for web sites that lend themselves to constructivist approaches and

technology. In addition, the site offers technology training resources as well as resources for professional development.

- *Tap into Learning* is a series of newsletters and is available both online and in print. These newsletters offer useful and highly practical information for K-12 educators wishing to use technology to support more constructivist learning approaches. *TAP into Learning* can be accessed electronically in an HTML format or downloaded as a PDF document. The newsletter was also mailed to 15,000 educators across SEDL's five-state region.
- *Videos.* These videos were designed as part of professional experiences for educators. They were used in a variety of ways with suggestions for creating learning centered environments supported by technology.

  Engaged Discoverers: Kids Constructing Knowledge with Technology. This video depicts K-12 classrooms in 16 schools throughout the Southwest where a variety of technologies support student-centered approaches in the classroom. Innovative teachers create environments where students collaboratively solve authentic problems using technology as a tool and new roles for students and teachers encourage kids to become "engaged discovers." Total running time: 28:25 minutes.

  Classrooms Under Construction: Integrating Student Centered Learning with Technology. This video portrays students, teachers, and principals from culturally diverse schools across the Southwest in the process of constructing learner-centered classrooms using technology. Through learner-centered professional development activities, teachers have the opportunity to experience for themselves the power of learning in this manner. Armed with this knowledge and support from principals, they gain the courage to make the transition from the traditional teacher-centered classroom to a more dynamic and creative learning environment. Students, teachers, and administrators learn as well as teach, sharing and learning new ideas, new technologies, and new strategies for building knowledge that relates to their own experiences and to the world they inhabit. Total running time: 24:20 minutes.

Selection of Study Sites

The following criteria were developed to identify classrooms to participate in the study based on SEDL's mission, priority areas, and past work in supporting teachers:

- High concentrations of economically disadvantaged populations (based on the percentage of students qualifying for free and reduced lunch)
- High concentrations of culturally and linguistically diverse students
- Rural and urban settings in the U.S./Mexico border region, Mississippi Delta region, and the Indian nations
- A commitment from campus and district administrators and from classroom teachers to support the creation of technology-rich learning environments that employ instructional approaches consistent with constructivist learning theory.
- A district technology plan with a financial commitment for ongoing purchase, support and maintenance of technology

- Evidence of prior reform-based or innovative projects designed to improve teaching and learning or promote the use of instructional technology
- The presence of an on-site technology coordinator or a contract with a local service provider
- Commitment from at least 25 teachers at the potential site school to work with ATRL staff for the duration of the project
- Administrative support through provision of time on the school calendar for professional development sessions and through assistance and support for teachers as they work to change their instructional practice
- Designation of a school or district staff member who will work with ATRL staff as a co-developer for the professional development sessions

Using information from *1997-1998 Quality Education Data* reports for each state in SEDL's region, recommendations from colleagues in the field, Internet searches, and presentations by schools at conferences, project staff compiled a short list of potential sites. ATRL staff visited the district offices and individual school campuses of these potential sites. Project researchers interviewed district technology coordinators and campus administrators and made presentations to teachers, explaining the project's goals and approaches.

School sites selected include one from each state in SEDL's region, with an additional site in Texas. The six site schools represent a variety of demographic and contextual characteristics in order to create a variable sample for the research study.

Because of the selection criteria used for selecting the six site schools to participate in this research study, it is important to reiterate that this is a purposive sample, rather than a random sampling. This approach is consistent with the qualitative inquiry process (Borg & Gall, 1989).

The *Arkansas* site was rural, with all of the district's schools on a single campus. Participant teachers represented the intermediate, junior high, and high school levels. Ninety-seven percent of the district's student population was white and the remainder was African American. Fifty percent of students qualified for free or reduced lunch. All of the 25 participating teachers were white.

The *Louisiana* site was a semi-rural middle school serving just over a thousand students, of whom over 65 percent were African American. Seventy-five percent of the students qualified for free or reduced lunches, and the school was identified as "at risk" according to state test scores. Twenty-three of the participating school staff were white; one was American Indian and one was Hispanic.

The *New Mexico* site was a rural middle school serving just under a thousand students, of whom 98 percent were Hispanic. Seventy-eight percent of students qualified for free or reduced lunch. Of the 25 participating teachers, 14 were white, 10 were Hispanic, and one was African American.

The *Oklahoma* site included five rural schools serving a total of approximately 1,850 students, of whom 62 percent were American Indian and 38 percent were white.

Seventy-eight percent of students qualified for free or reduced lunch. Faculty size at the five schools ranged from a low of 15 teachers to a high of 48. Most teachers in the schools were white; a small number were of Cherokee ancestry; no specific data were initially available regarding the race/ethnicity of the 25 participating teachers, though all were either white or American Indian.

The two Texas sites included both an urban and a rural elementary school. The *Texas rural* site served just fewer than 700 students, of whom 94 percent were Hispanic. One hundred percent of students qualified for free or reduced lunch. Of the 28 participating teachers, 15 were white and 13 were Hispanic.

The *Texas urban* site was an elementary school serving approximately 500 students, of whom 42 percent were African American and 40 percent were Hispanic. Eighty-five percent of students qualified for free or reduced lunch. Of the 30 participating teachers, 20 were white, six were Hispanic, and four were African American.

Data Collection

ATRL staff collected baseline, mid-project and end-of-project data for each participant teacher. Exhibit I illustrates the principal sources that captured data across all sites for the two-year duration of the ATRL project.

Exhibit 1: Data Collection Schedule and Sources

Data Source	Instrumentation	Sample	Data Collection Schedule				
			Base -line	On-going	End of year 1	End of Year 2	Other
Classroom observations	Observation protocol	All participant teachers	◆		◆	◆	
Self-report of personal information	Questionnaire	All participant teachers	◆				
Self-assessment of computer skills	Computer skills checklist	All participant teachers	◆		◆	◆	
Informal interviews & observations		All participant teachers		■			
Formal, in-depth interviews	Interview guidelines and question sets	Six case study subjects					❍
Sample lesson plans and curriculum units	Lesson plan template	All participant teachers	◆		◆	◆	
Feedback from professional development sessions	Evaluation questionnaires, open-ended questions	All participant teachers					•
Videotaped interviews & classroom episodes		Selected teachers, co-developers, administrators					❑
Field notes		All participating teachers; other school staff		◆			
E-mail correspondence		All participating teachers; other school staff		◆			
Self report of use of students' funds of knowledge	Survey/Questionnaire	All participant teachers				◆	
Teaching, Learning, & Computing:Teacher Survey	Survey/Questionnaire	All participant teachers				◆	

◆ Data collected from each teacher.
■ Each teacher was interviewed once over the course of the project.
❍ Each teacher selected for a case study was interviewed multiple times over the course of the project.
• Feedback was collected after each of the professional development sessions.
❑ Selected volunteers were videotaped once during the course of the project.

Data Collection – Procedures

Tier One – All Classrooms

Baseline data. Baseline data were collected for each site during the spring and fall of 1998 to provide an initial picture of the teachers, students, and classroom practices at the sites. Demographic data for each school and school district were acquired from the 1997-1998 *Quality Education Data* report. Descriptive information about the schools and communities was collected during the site selection process primarily by first-hand visits to the individual school campuses. ATRL staff conducted initial observations in the classrooms of the 150 participant teachers, using the classroom observation protocol. Sample lesson plans, a teacher self-assessment of computer skills, and teacher personal profiles also were collected from all teachers to provide additional information and triangulation of observation data.

Subsequent data collection. Mid-project data were collected for each site during the spring of 1999 to provide an interim picture of the teachers, their classrooms, students, and classroom practices at each of the six sites to determine what patterns and practices were emerging. Teacher interviews and videotaping also were completed over the two-year period, while collection of field notes, informal interviews and e-mail correspondence were ongoing. Data from classroom observations, self-assessment of computer skills, and lesson plans and curriculum units were collected at the end of Year One and Year Two. Feedback from professional development sessions was collected after each of the six professional development sessions during Year One and Two. At the end of year two, teachers completed a self-report regarding use of students' "funds of knowledge," and the *Teaching, Learning, and Computing* (Becker & Anderson, 1998) teacher survey.

Tier Two – Six Case Studies

Case study data collection. At the end of the second year of the project, based on preliminary analyses of observations, field notes, and electronic communication sources such as e-mail; ATRL staff identified six classrooms that emerged as examples of constructivist learning environments supported by technology. Classrooms were selected to represent a range of constructivist practices and uses of technology to support teaching and learning, a variety of grade levels serving student populations from diverse cultures, and a variety in the amount of technology available in each classroom. Teachers of those classrooms represented a range of both teaching experience and experience using technology, as well as movement along the continuum from low technology–low constructivism to high technology–high constructivism.

In addition, case study subjects participated in three, one-hour interviews. Appendix 8 contains the question sets used for these interviews. Each subject was asked about their teaching practice, teaching philosophy, use of technology, classroom management, and how they were able to change their teaching practice to create constructivist learning environments supported by technology.

By describing these classrooms in-depth, the case studies illustrate the models of CLEs supported by technology that emerged over the course of the project and help explain the process required for doing so for other educators who wish to implement like environments. The variety of contexts and practices is intentional as it increases the ability of other teachers to find an example with which to identify.

Case Studies

Arkansas. The Arkansas case study site was located in a small community at the foothills of the Ozark Mountains, in the northeast corner of the state and adjacent to a major river. Agriculture, logging, and other small industries supported the local economy. This community's available labor force can be described as "blue-collar." All of the district's schools were on a single campus. Ninety-seven percent of the district's students were white, and 50 percent of students qualified for free or reduced lunch.

The case study teacher in this site, Roberta, was a fourth grade teacher with more than 20 years of teaching experience. The type of technology-assisted constructivist learning environment that Roberta exemplified may be characterized as a "Project-Based" learning model.

Louisiana. The Louisiana case study site was situated in a middle school in a semi-rural community in the Acadiana region of the state. Over half (65 percent) of the student population was African-American with strong roots in the Creole culture; most of the rest of the students were white, with strong roots in the region's Cajun culture. The school was classified by the state as "at risk." 75 percent of students qualified for free or reduced lunch.

Jeanette was the case study teacher at the Louisiana site and taught 6th, 7th, and 8th grade Language Arts. She was beginning her fourth year of teaching at the project's inception. The type of technology-assisted constructivist learning environment that Jeanette exemplified may be characterized as a "Collaborative-Learners" model.

New Mexico. The New Mexico case study site was situated in a rural agricultural community located in a river valley in the south central portion of the state, near the Rio Grande River. This area is rich in Hispanic culture and history with its close ties to Mexico. Migrant workers, following the harvests, move in and out of the area, depending on the season. However, many families have lived in the area for several generations, some establishing successful businesses. Spanish remains the dominant spoken language. The student population, like that of the district, was more than 90 percent Hispanic; nearly 80 percent of students qualified for free or reduced lunch.

Kay was the case study teacher at the New Mexico site and had been teaching for 14 years in this same middle school. At the beginning of the project she taught low-performing students in a language arts reading lab. At the beginning of the second year, she was assigned to teach Language Arts in a general 7th grade classroom. The type of technology-assisted constructivist learning environment that Kay exemplified may be characterized as a "Student-Focused" model.

Oklahoma. The Oklahoma case study site was situated in a depressed rural county in eastern Oklahoma near the foothills of the Ozark Mountains. The main industries of the area are a regional state college and numerous plant nurseries, as well as tourism related to two large recreational lakes. Almost all the schools in the county served a predominantly American Indian population who sought to preserve their heritage, in spite of the low proportion (three percent) that speak Cherokee as their first language. The schools enrolled a total of 1,860 students, of whom 62 percent were American Indian, primarily Cherokee. Almost 80 percent of students in the five schools qualified for free or reduced lunch.

Clay was the case study teacher from the Oklahoma site and taught several different subject areas in the 6th, 7th, and 8th grades, with responsibility for as many as six class preparations each day. Clay also coached football and drove a school bus. The type of technology-assisted constructivist learning environment that Clay exemplified may be characterized as a "Wishful-Thinker" model.

Texas rural. The rural Texas case study site was situated in a small Hispanic community west of El Paso, Texas, near the banks of the Rio Grande River. The Mexican American Legal Defense Fund has identified this border town as containing one of the poorest census tracts in Texas. This agricultural community is located in close proximity to Mexico and is near a major interstate highway. Plans for widening the interstate are expected to make the region more desirable to developers. Small locally owned and franchise businesses cluster on either side of the main business highway. The tax base and tax revenues for the district are increasing with new industrial growth in the area. Seventy percent of households speak Spanish as their first language. The Texas rural site served just fewer than 700 students, of whom 94 percent were Hispanic. One hundred percent of students qualified for free or reduced lunch

Martha was the case study teacher from the rural Texas site and taught at this school throughout her career, working in a first grade classroom her first two years, and then changing to the third grade which she has taught the past six years. The type of technology-assisted constructivist learning environment that Martha exemplified may be characterized as a "Learning-Centers" model.

Texas urban. The Texas urban case study site was set in a growing section of a central Texas city whose population is over one million and according to the *American City Business Journal*, the city is one of the fastest growing in the United States. The site school is a new elementary campus located near a major interstate highway. The area around the school is growing, as evidenced by the construction of new apartments and single-family homes. Although the school is in a newly developed area, an established mobile home park lies within the boundaries of the school attendance area. Children who attend the school are from primarily low-income families; 80 percent of the student population is classified as economically disadvantaged. Approximately 40 percent of the school's 510 students are African American; 40 percent are Hispanic; and 20 percent are White. Eighty-five percent of students qualified for free or reduced lunch.

Susan was the case study teacher from the urban Texas site and taught second grade. She had transferred to this new school along with its principal, after teaching for eight years in another elementary school. The type of technology-assisted constructivist learning environment that Susan exemplified may be characterized as a "Cross-Grade Collaboration" model.

The complete six case study reports can be found in Appendices 1-7.

Data Analysis

Grounded theory. The ATRL study used a grounded theory approach to understand what was taking place in classrooms of participating teachers', the contexts of those classrooms and how teachers operated within those contexts.

Grounded theory is a qualitative research approach where theory emerges from the data, or in other words, the theory is "grounded" in the data rather that attempting to prove a theory from the data. Grounded theory research begins by focusing on an area of study and gathers data from a variety of sources, including interviews and field observations. Once gathered the data are analyzed using coding and theoretical sampling procedures. When this is done, theories are generated, with the help of interpretive procedures, before finally being written up and presented (Haig, 1995).

Analysis was ongoing throughout all phases of the ATRL study and used the constant comparative method originally developed by Glaser and Strauss (1967) which allowed patterns to emerge that were relevant to the situations being studies. By interweaving the data collection and analysis, insights and clarification grew and helped contribute to an emerging picture of classroom models of constructivist learning environments (CLEs) supported by technology.

Exhibit 2 provides a listing of the different data sources for analysis, both qualitative and quantitative, and which contributed to answering the three research questions.

Exhibit 2: Data Sources for Analysis

Research Question	Quantitative Data Sources	Qualitative Data Sources
1. What do constructivist learning environments look like in practice; particularly in classrooms with high populations of culturally and linguistically diverse students?	Observation Protocol *Funds of knowledge* questionnaire	Field notes Informal observations Informal interviews Lesson plans Video tape interviews and classroom episodes
2. How can teachers be assisted in developing constructivist learning environments supported by technology?	Observation Protocol Staff development hours *Teaching, Learning & Computing Teachers* survey	Field notes Informal observations Informal interviews Case study interviews Lesson plans Staff development evaluations Video tape interviews and classroom episodes
3. How does technology facilitate the development of a constructivist learning environment?	Computer Skills checklist *Teaching, Learning & Computing Teachers* survey	Field notes Formal and informal observations Informal interviews Case study interviews Lesson plans Video interviews and classroom episodes

Exhibit 2 serves as an organizer to distinguish quantitative from qualitative data sources. However, for analysis purposes and to answer the three research questions, quantitative and qualitative were initially analyzed separately and then analyzed by cross tabulation or pattern matching to identify possible emerging models that suggest or point to possible answers to the research questions.

Qualitative Data Analysis Procedures

As Miles and Huberman (1984) have noted, "qualitative data analysis is a continuous, iterative enterprise"(p.23). HyperResearch software was used to code and analyze data gathered from interviews, observations, and field notes to test propositions about themes in the data.

Analysis process. The following steps structured the analysis process for each qualitative data source:

1. Data was gathered at each site and from each participant teacher in the form of classroom observations, formal and informal meetings and interviews, self-reports of personal information, sample lesson plans and curriculum units, field notes, site reports, e-mail correspondence, and self-reporting questionnaires.
2. Case study subjects were interviewed and those interviews were transcribed into an electronic text file.
3. ATRL staff thoroughly read all data sources to develop an initial sense of scope, patterns, and emerging themes (Brooks, 1993).
4. An initial set of categories for analysis was developed such as: the role of the teacher, teacher's practice, classroom organization, student activities, curriculum

design, technology use in these classrooms, and school context. Analysis within each of these categories produced further sub-categories for analysis.
5. Data and categories were reviewed multiple times and then a common set of codes using HyperResearch emerged for coding.
6. Additional codes and categories were developed as the analysis proceeded.

Internal validity. Several steps were taken to strengthen internal validity:
1. *Clarification.* The researchers' assumptions, worldviews, and theoretical orientation as they relate to the research topic were clarified before the study began (Merriam, 1988). At the beginning of the project, the ATRL project team spent several weeks reviewing the literature on constructivist learning theory to find a common understanding of the theoretical framework for this study.
2. *Triangulation of data.* ATRL staff carried out triangulation of data sources, methods, and investigators. Qualitative data were read, coded, analyzed and cross-tabulated to discover emerging patterns (Denzin, 1978).
3. *Repeated data collection.* Data was gathered at the beginning of the project, at mid project, and at the end of the project as well as ongoing across the six sites during the two year period of the project. Exhibit I provides an overview of the data collection.
4. *Verification for plausibility.* ATRL staff discussed their interpretations and findings from the sites among themselves and with research participants to verify plausibility (Lincoln & Guba, 1985).
5. *Peer review.* The methodology and findings were examined and critiqued by peers at a national research conference and with researchers at a Research Roundtable.

Written presentation. To help readers apply the findings to other situations, the following steps were taken:
1. Rich descriptions are provided through in-depth case studies (Lincoln & Guba, 1985).
2. The typicality of the sites was described (Goetz & Le Compte, 1984).
3. Researchers maintained an electronic audit trail and paper trail with field notes, site reports, and other observation data that described how data were collected, categories derived, and decisions made throughout the inquiry (Lincoln & Guba, 1985).

Quantitative Data Analysis Procedures.
Quantitative data analysis was performed on four data sources:
1. Checklist portion of the classroom observation protocol,
2. Computer Skills Checklist,
3. *Teaching, Learning, and Computing Teachers Survey*, and
4. "Funds of Knowledge" questionnaire.

Using SPSS software, analyses of the observation protocol and the Computer Skills Checklist assessed change over time and suggested reasons for that change.

SPSS software was also used for data analysis of the responses to the *Teaching, Learning, and Computing Teachers Survey (TLC)* to compare participants in the project to nationwide results of the survey. The national results were based on random sampling and without benefit of the professional development intervention such as was provided

through this project. A comparison of project participants (purposive sample) to the national probability sample examined the professional development intervention in light of changes in teachers' practice.

Because the ATRL project was working with students of highly diverse populations, it was helpful to see how teachers access or capitalize on diversity in their classrooms by tapping into students "prior knowledge" or "funds of knowledge." To examine this process and help answer research question one "What do constructivist classrooms look like in practice?" ATRL researchers developed and administered a "funds of knowledge" questionnaire to all project participants.

Analysis of Data Sources by Research Question

1. What do constructivist learning environments look like in practice; particularly in classrooms with high populations of culturally and linguistically diverse students?

Classroom observations provided data related to this question. Part 1 of the observation protocol (researcher notes) were coded to elicit specific practices observed in the classroom. These data sources further informed answers to this research question. Coding categories included instructional strategy, activity types, and levels of technology use, student and teacher roles, and teacher and student demographics.

To answer research question one, Part 2 of the observation protocol was coded, entered into a database and analyzed using SPSS statistical software package. Types of analyses included:

- Cluster analysis, in order to sort cases by common characteristics into groups or clusters. This classification scheme allowed tracking of movement among teachers in terms of constructivist approaches.
- Means tests, in order to determine teachers' "scores" in each of the descriptors in the observation protocol. These means were used to determine low, medium-low, medium-high, and high constructivist practices for each project teacher. Change in mean scores from baseline to the end of Year One and Year Two were noted and regarded as an indication of change in practice if they achieved a level of significance of .05 percent.
- Correlations, in order to determine the strength of relationships among the six constructivist approaches
- Counts and frequencies, in order to determine the total scores of a particular piece of data as well as the rate or commonality of a particular practice.
- Cross tabulations of teachers' use of technology and level of use of constructivist approaches as recorded on the observation protocol during formal classroom observations.

A *Funds of Knowledge* questionnaire (Appendix 15) was developed and administered to participating teachers. The purpose of this questionnaire was to collect information from participating teachers regarding (1) the perceived importance of exploring students' prior knowledge, (2) the strategies they used to access such knowledge, (3) the

kinds of information they were able to elicit from students, and (4) the ways in which they used the information in their instructional practice. The questionnaire was scored to determine teachers' self-perceptions of students' prior knowledge. Responses to this questionnaire were then cross tabulated with constructivist composite scores from the observation protocol and analyzed.

2. How can teachers be assisted in developing constructivist learning environments supported by technology supported by technology?

To inform answers to research question two, analyses of observation data included comparisons across the categories on the protocol to document which practices modeled during professional development may have transferred into classroom practice. Comparisons of these categories and comparisons of observation data and the self-assessment of computer skills with field notes were also made to inform any differences in support required at various grade levels.

The baseline computer skills checklist was compared with subsequent administrations to look for relationships between teachers' technology skills and constructivist practice. The computer skills checklist was also compared to professional development session offerings to identify computer skills increase as a result of professional development sessions.

Analysis of videotaped teacher interviews and the in-depth case study interviews helped reveal the personal process of change that individual teachers must deal with when participating in an innovation. Interviews allowed teachers to discuss their fears and frustrations as well as successes and milestones in transforming their practice into constructivist classrooms supported by technology.

The Teaching, Learning, and Computing Teachers Survey provided an additional profile on each teacher and the group as a whole. This instrument asked teachers what they believe about teaching and learning and what support they need to help them become the teachers they want to be. These data were compared to observation data as well. As the participating teachers received professional development designed to assist them in creating CLEs, one might hypothesize that rankings on constructivist practice and use of technology would be higher than for the national sample. The statistical method for this comparison was an Eta correlation ratio that measured the strength of relationships between the ATRL teachers and the national sample.

3. How does technology facilitate the development of a constructivist learning environment?

The *Teaching, Learning, and Computing Teacher Survey* allowed comparisons to national results about the use of technology and constructivist practices, contributing to answers for this research question. Each teacher presented a lesson as part of a summary activity in the sixth and twelfth professional development sessions. These lessons were coded and compared to staff development and follow-up support to provide evidence of change in practice and use of technology.

The self-assessment of computer skills (Computer Skills Check List) was analyzed by computing averages of scores by category for each teacher and ranking teachers as having no experience, some experience, or much experience with a particular software application based on those averages. Subsequent administrations were compared to document changes in teachers' self-assessment of level of computer skills. Means tests were used were used to measure changes in technology proficiency over the course of the two years.

The self-assessment of computer skills was compared to observations and field notes to look for patterns that contribute to answers for research question three. Informal and formal interviews and observations documented teachers' personal feelings and perceptions and their regard for technology use in their classrooms.

Chapter 2 - Data Analysis

Findings: Research Question One
What do constructivist learning environments look like in practice?

Introduction

The *Applying Technology to Restructuring and Learning* project began with certain assumptions about what constructivist learning environments looked like in practice. These assumptions were derived from a review of the literature on constructivist learning theory and staff's own experiences as K-12 educators. These assumptions were codified in the classroom observation protocol and were integral to the way staff developed and conducted professional development. Primarily, staff believed that all constructivist approaches could be captured and documented and that one model of a constructivist learning environment would emerge as a result of the same interventions.

Data Sources

Quantitative data analysis and reporting in this section were derived from Part II of the classroom observation protocol (See Appendix 9) and the Funds of Knowledge questionnaire (See Appendix 13). Seventy-two ATRL participants were observed teaching for approximately 45-60 minutes the baseline year of this project, at the end of year one and again at the end of year two. Informal teacher interviews, informal classroom observations, field notes, video taped interviews and classroom episodes, and feedback from staff development sessions collected during the two years of the project further inform us about emerging patterns in classroom practice and the changes and challenges that the project teachers have dealt with during the course of this project.

Formal classroom observations were conducted using an observation protocol. The protocol is attached to this report as Appendix 9. This "field instrument" was created for data gathering purposes and is based on a common understanding among project staff of what a constructivist classroom supported by technology looks like in practice. It is based on a review of the literature and a review of observation protocols developed by other researchers interested in constructivist learning environment and was developed, pilot tested and field-tested by SEDL staff.

Part One of the Classroom Observation Protocol (researcher notes) was coded to elicit patterns of practice observed in the classroom. This data source helped suggest answers to answer the three research questions. Coding included instructional strategy, activity types, levels of technology use, student and teacher roles, and teacher and student demographics.

Part Two of the Classroom Observation Protocol contained descriptors of observable characteristics of a constructivist learning environment supported by technology, regardless of content area or grade level. The descriptors in this protocol were formulated around the six principles of constructivism that served as the theoretical basis for this study. The descriptors for each of these six principles were coded on a scale from one to five by SEDL staff for each classroom observation. Each descriptor was then analyzed to determine the level of constructivist practice for each project teacher. Change in mean scores from baseline to end of year one and year two were noted and regarded as an indication of change in practice. The five levels of constructivist practice observed (for each descriptor) were: (1) *Not evident*, (2) *Minimal*, (3) *Sometimes*, (4) *Frequent*, (5) *Regular practice*.

Results from the observation protocol were entered into an SPSS database and analyzed. Types of analyses included:

- Cluster analysis, in order to sort cases by common characteristics into groups or clusters. This classification scheme allowed tracking of movement among teachers in terms of constructivist approaches.
- Means tests, in order to determine teachers' "scores" in each of the descriptors in the observation protocol. These means were used to determine low, medium-low, medium-high, and high constructivist practices for each project teacher. Change in mean scores from baseline to the end of Year One and Year Two were noted and regarded as an indication of change in practice if they achieved a level of significance of .05 percent.
- Correlations, in order to determine the strength of relationships among the six constructivist approaches
- Counts and frequencies, in order to determine the total scores of a particular piece of data as well as the rate or commonality of a particular practice.
- Cross tabulations of teachers' use of technology and level of use of constructivist approaches as recorded on the observation protocol during formal classroom observations.

Sample Size

The project began with 150 participants. However, ten of the participants were not classroom teachers, but were librarians, computer lab managers or district-level personnel with no formal teaching responsibilities and were therefore not part of formal classroom observations. Though the majority of participants continued to participate in the ATRL project on a regular basis over the two years of the project, the final data set contained information only on 72. What happened to data for the remaining 68 participants?[2] This differential in the number of project participants and those participants in the final data set is the result of a number of factors. First, of the remaining 68 participants, 20 teachers were lost to the ATRL project through attrition: they either left the project of their own volition or were removed by their principal, for

[2] Again, 10 of the original 150 participants were not classroom teachers and thus were not observed in formal classroom observations.

whatever reasons, to make room for another candidate.[1] Next, approximately 12 teachers were lost to the project through reassignment to other schools or a job change that removed them from the classroom. Though replaced in the project, their replacements were not included in the final data analysis as there was no baseline data for comparison.

Finally, because of scheduling conflicts, pregnancy leaves, field trips and a host of other logistical reasons, ATRL staff were not always able to observe approximately 36 other project teachers during the three scheduled observation times (baseline year, year one and year two) over the course of the two years.

Table 1 provides some descriptive data that allow for a general comparison between the 68 teachers not included in this final research report and the 72 who comprised the final data set.

Table 1: Baseline Characteristics: Teachers Not Included in Final Data Set vs. Teachers Included in Final Data Set

Characteristics	Teachers Not Included in Final Data Set N=68	Teachers Included in Final Data Set N=72
Ethnicity		
White	48	58
Hispanic	15	13
African American	4	1
American Indian	1	
Grades Taught		
Pre-K-4	37	22
5-8	27	45
9-12	4	5
Mean Score: Observation Protocol[2]	$\bar{X}$=2.07 STD=.73 SIG=.000	$\bar{X}$=1.96 STD=.659 SIG=.000
Mean Score: Computer Skills Checklist	$\bar{X}$=.59 STD=.385 SIG=.000	$\bar{X}$=1.39 STD=.475 SIG=.000

$\bar{X}$ is the mean (average) of teachers' scores. STD is the Standard Deviation, which illustrates how tightly all the various examples are clustered around the mean in the data set. SIG is the significance level.

While those teachers not included in the final data set evidenced slightly higher scores in terms of constructivist approaches (2.07) than those included in the final data set (1.96), their overall computer skills were much weaker (.59 versus 1.39). Thus, while their absence from the final data analysis probably did little to impact overall scores in terms of constructivist approaches, had they been included in final analysis, the

[1] Most principals who removed a teacher from the ATRL project did so after year one. Therefore, there is no baseline data for these newer participants.
[2] Both means for the observation protocol and computer skills checklist were derived from one sample T-tests at a 95% confidence interval.

baseline scores for *all* teachers would have been considerable lower, and thus greater overall progress in technology proficiency shown over the course of the project.

Data Analysis: Classroom Clusters

There was no one model or prototype of a constructivist learning environment. Rather, analysis of quantitative and qualitative data reveals that classrooms fell along various points on the continuum of constructivist practices. For the purposes of classification, classrooms were placed in clusters along a continuum of constructivist approaches: low, low-medium, high-medium and high. *The classifications are comparative, not absolute, and indicate that these classrooms are low, medium, or high in relationship to one another.* The purpose of placing classrooms in clusters was to "cluster" or categorize classrooms according to a set common characteristics and to track the movement of these clusters over two years: Where did classrooms start out and where did they move? Did classroom remain in their particular category over time and if so, why? Each category will be discussed below in greater detail.

Low Constructivism. Fifteen percent of classrooms observed at the end of year two of the ATRL project were identified as "low constructivism." This type of classroom fell on the lowest end of the constructivist spectrum with low or no constructivist practices. Low constructivist environments were teacher-centered: the teacher did most of the talking and the major class dynamic was whole group instruction. Typically, the teacher stood or sat in front of class with students seated in rows. Such classrooms were characterized by a high degree of centralization and conformity. All students worked on the same activity at the same time. The teachers in this category worked with the whole class as a group, or rotated around the room to assist individual students.

Discourse was quite limited, consisting mainly of students responding to teacher-directed questions, usually providing short or rote answers. Student contributions or attempts to contribute were often not acknowledged and students were offered little opportunity to express their viewpoints or share their knowledge about a particular domain. There was usually little or no teacher-supported interaction between students. Though there may have been some use of small groups, there was often little student autonomy and students worked individually on teacher-assigned tasks.

Technology use
In terms of materials, traditional resources such as the overhead projector, textbooks, worksheets, paper and pencil, and the chalkboard were used. Though these classrooms may have had classroom computers, technology was infrequently or not used by students. When used, these classrooms tended to employ tools that mirrored traditional practices, such as students taking *Accelerated Reader* tests individually or the use of computers for teacher productivity.

Medium-low Constructivism. By the end of year two 24 percent of the formally observed classrooms were identified as medium-low constructivism. Medium-low constructivism classrooms differed from low constructivism classrooms primarily by the way they were organized for learning and in their use of technology—though the most obvious distinction between the two may be one of form as opposed to substance.

Within these medium-low classrooms, students typically tended to sit together in groups working on particular activity. Quite often these groupings were in the form of learning centers in which students were engaged in a number of discrete activities that were formerly conducted as a whole group activity. The worksheet was still prevalent in the low-medium constructivist classroom. Of the activities occurring at each station, approximately half may have been "open ended," that is requiring greater student creativity, problem solving, or greater student autonomy. Though students may have exchanged ideas on assignments, and were allowed to experiment and explore new ideas, students tended to be working together more individually than collaboratively.

The degree of collaboration varied across classrooms within this category. In some classrooms, students were arranged in loosely cohered groups, interacting with materials and to a much lesser extent, with one another, in solving problems. In others, the entire class was involved in the same activity at the same time. Though working in collaborative settings, students communicated very little or not at all, and the main communication pattern was still teacher to student(s).

Technology use

There was no pattern of technology use in a low-medium constructivist learning environment. For example, students in a low-medium constructivist classroom may have been engaged in an open-ended activity such as the creation of a product of their choosing, or in a more close-ended assignment, for example an *Accelerated Reader* test or word processing a report. Oftentimes, however, the computer activity was the most open ended, eliciting student creativity, problem solving or critical thinking skills.

While the teacher demonstrated activities, students engaged in some hands-on activities and more skilled students assisted less skilled students. The teacher solicited students' knowledge about a particular topic and generally offered more in-depth questioning of students' prior knowledge, understanding and opinion. However, patterns of communication were still predominantly teacher-student, versus student-student.

Medium-high Constructivism. Approximately 32 percent of classrooms formally observed were identified as medium-high constructivism. Medium-high constructivist classrooms differed from medium-low classrooms in terms of substance rather than style. They were more learner-centered with the teacher in the role of facilitator or working with small groups of students. In such classrooms the teacher employed a variety of instructional methods, including class discussion, student writing, and student reading and responding to questions.

Students also worked in collaborative groups or pairs and typically interacted with a variety of materials: books, reports, worksheets, individualized instruction from the teacher, and the World Wide Web, to gain information. In some classrooms students were responsible for their own work, as opposed to a collaborative product. Some of the classrooms were characterized by teacher-led activities, but in such cases the teacher asked open-ended questions and solicited students' prior understanding. While the primary pattern of communication in medium-low constructivist classrooms was either teacher-student or a weak student-student pattern of communication, in medium-high

constructivist learning environments the communication pattern was student-student and student-teacher.

While medium-high constructivist classrooms, like their medium-low counterparts, often employed learning stations, the activities in each tended to be more thematic and open-ended and activities distributed. In other words, while students, at their various centers, may have been working on the same thematic unit, the activities at each station varied and students were not all doing the same thing at the same time. While students might not be organized into centers, they were in fact working either individually or collaboratively on multiple activities.

Technology use

A number of technology management models were evident in this medium-high constructivist environment. First, learning centers were employed in which students were provided with greater opportunity for communication, peer tutoring and collaboration, though the degree and kind of collaboration tended to vary across classrooms. None of the centers observed was thematically integrated, and some were based upon traditional content such as cursive handwriting and alphabetizing spelling words. In all of the centers the students interacted with each other by talking and discussing the task at hand, although in most of the centers students were responsible for their own written assignment or product for assessment.

A second model involved "concurrent groupings" where part of the class worked on a task at the computer while the rest of the class focused on another activity. Sometimes the activities were related to each other, for example in two classrooms, four pairs of students gathered information from the Internet to complete an assignment about a particular author. At the same time the remainder of the students who were not on the Internet wrote a personal response to the author about the story they listened to. In a third classroom, the majority of the class worked on a reading assignment for a class novel and a creative writing assignment, while two students worked with a student teacher on a *Hyper Studio* stack.

A third model involved all students having access to all computers. This model occurred in very specific settings—a library and computer lab—where access to multiple technology was more prevalent than in the classroom. In the computer lab most students had their own computer, and in the library groups of three to five students created a group presentation. Some of these students were practicing the oral part of their presentation, while other small groups worked at the computer.

In all of the three models described above, as students were engaged in activities, the teacher either worked with a small group of students, or rotated among students, and offered assistance as needed.

Though medium-high classrooms exhibited certain models of technology management there was no discernible pattern of technology use. Since activities in general tended to be more open ended, technology use also conformed to this pattern. Unlike the medium-low constructivist classroom, where the computer station activity may have

been the most open ended and creative of the stations, there was no indication that this was so in a medium-high constructivist environment.

High Constructivism. Twenty-nine percent of all classrooms formally observed were identified as high constructivism. The high constructivist learning environments differed from the medium-high constructivist learning environments in terms of the frequency and depth of student-centered approaches. These classrooms were characterized by students working together, autonomously, cooperatively and collaboratively, at their own pace and on a real world topic of their own choosing, with different groups conducting different activities simultaneously. Students appeared highly engaged and motivated by the curriculum and were allowed to come up with their own expressions of a problem they had solved or a product they had created.

In such high constructivist classrooms, the teacher was truly a facilitator or guide, typically circulating among students and observing student work. Most noticeable was that teacher-talk, in relation to that of the students, was minimal. In most high constructivism classrooms, the teacher rarely talked to the class as a whole and answered questions or offered guidance only when it became obvious that students had exhausted all other forms of assistance. Further, within a high constructivist learning environment, the teacher appeared to be a co-learner with students, spending less time in conveying information, and more time in guiding students to sources or avenues of information. Field notes and formal observations noted that teachers in high constructivist classrooms often learned from and with students. Most often the learning took the form of some sort of new technology use but also included new concepts or facts within the subject area being studied. The research of Roehrig-Knapp & Glenn (1996) supports this "co-learning" role of the teacher in a constructivist learning environment.

Technology use

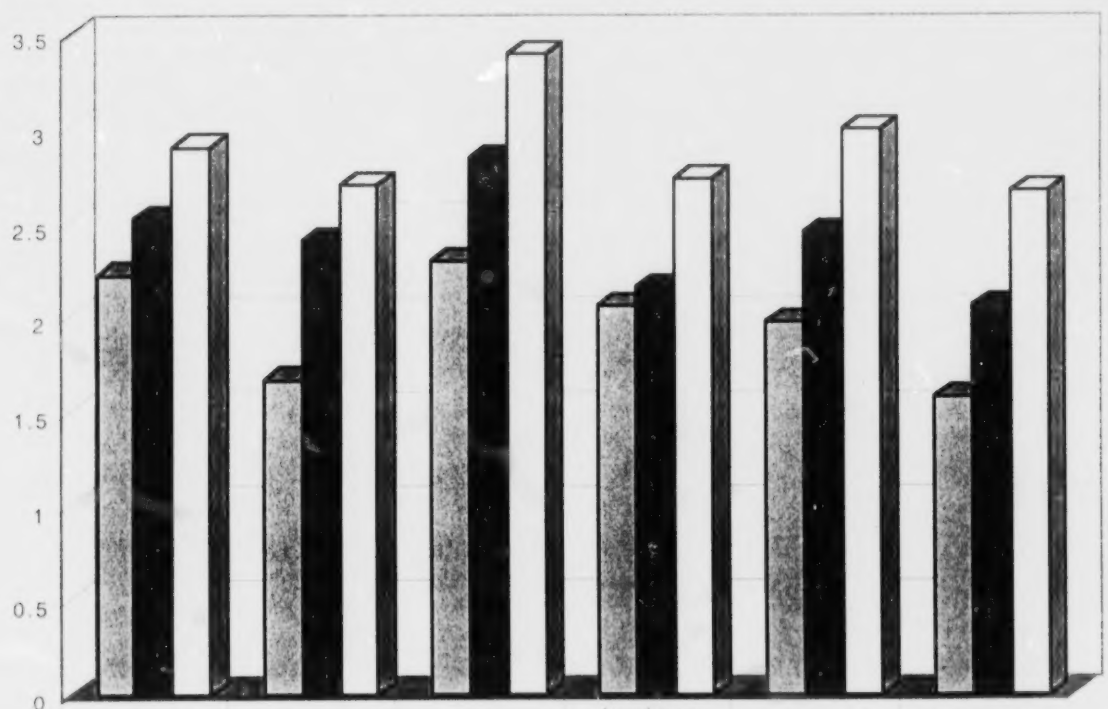
Students used several computer applications—on-line encyclopedias, the World Wide Web, presentation software, content-specific CDs, graphics software and word processing—for the purposes of research and expression. In all instances of high constructivist learning environments observed, students were independently using computers to solve problems, create intellectual products, produce written work, and other classroom activities. These classrooms had an atmosphere of inquiry and communication that encouraged student contribution and direction. Students in such a high CLE appeared to be highly engaged in the learning process and enjoyed a good relationship with their teachers.

In such an environment the teacher was the model of a guide, facilitator, coach and mediator. For example, in one 7th grade language arts class, the teacher circulated among groups quietly. ATRL observation notes report not having heard the teacher address the class as a whole. In another 6th grade science class the teacher assisted students in making a PowerPoint slide show on the phases of the moon. She took care to provide answers only when students exhausted other options for help and made sure to never touch the mouse or keyboard when helping the students.

Data Analysis: General Results across Six Principles of Constructivism

As described in the previous section, analysis of quantitative and qualitative data revealed that classrooms fell along various points on a continuum of constructivist practices. Consequently, no single prototype or model of a constructivist classroom emerged from the data. However, initial data indicated that some preliminary conclusions can be drawn about how and where constructivist learning environments occur. Figure 1 compares the means of the six working principles of constructivism across all classrooms over the two years of the project.

Figure 1: Change in Constructivist Approaches – Baseline to Year Two



	Prior Knowledge	Multiple Resources	Action/Reflection	Learning as Developmental	Social Interaction	Internal Mediation
1998 Mean	2.23	1.67	2.3	2.06	1.98	1.58
1999 Mean	2.53	2.41	2.84	2.16	2.45	2.06
2000 Mean	2.9	2.7	3.39	2.73	2.99	2.67

The movement of classrooms across the constructivist continuum will be discussed in greater detail in Question Two. However, as can be seen from Figure 1 teachers made in some cases, significant movement in constructivist approaches over the course of two

years. As a reminder, the five levels of constructivist practice observed (for each descriptor) are: (1) *Not evident*, (2) *Minimal*, (3) *Sometimes*, (4) *Frequent*, (5) *Regular practice*.

What do such numbers mean from an instructional perspective? The observation protocol examines how the teacher's knowledge of constructivist learning theory impacts the way he/she organizes the classroom for learning. Overall, in the baseline year classrooms, there was minimal evidence of teachers' familiarity with constructivist learning theory or the instructional practices based on such theory. Thus, there was minimal eliciting of students' prior knowledge or allowing for activities that prompted students to both act and reflect on their learning. Use of multiple tools or resources was minimal to the point of being not evident as were collaborative leaning and internal mediation of learning

By the end of the project, it was evident that teachers' cognizance of constructivist learning theory had impacted instruction. Teachers' use of prior knowledge was more common. Students were more likely to access multiple tools and resources in terms of their learning and to work collaboratively with their peers on a particular unit of study. The curriculum appeared to allow for greater action and reflection on the parts of the learner. Finally, students appeared to be engaged in more self-guided exploration and the teacher seemed to encourage greater student autonomy and self-guided reflection.

It appears from the ATRL data that as teachers create constructivist learning environments, there was a correlation among certain types of constructivist approaches. That is, teachers tend to use certain constructivist approaches in combination with one another. Table 2 presents correlations among the six constructivist approaches. Correlations determine the strength of relationships between variables. The correlation coefficient is always between –1 and 1. If the correlation coefficient is positive, the variables are positively related. The closer the coefficient is to 1, the stronger the *positive* relationship. Conversely, if the correlation coefficient is negative, the variables are negatively related. The closer the coefficient is to -1, the stronger the *negative* relationship.

As illustrated by Table 2, all of the constructivist approaches observed in the classroom are in varying degrees related to one another. It appears, for example, that teachers' utilization of action/reflection has the strongest positive relationship with the other variables. A case may be made for this relationship: In prompting students to become more active learners, the teacher provides multiple tools and resources (.721) and encourages student collaboration and group problem solving (social interaction—.847). By providing opportunities for reflection, the teacher may elicit prior knowledge (.716) and provide students with learning opportunities that impel them to match new knowledge with existing beliefs thus resulting in the creation of new knowledge (the developmental component—.804) and provide students with opportunities for self-guided exploration and to design methods for problem solving (internal mediation—.791).

Table 2: Correlation among Constructivist Approaches Year Two

	Prior Knowledge	Multiple Resources	Action/ Reflection	Learning is Developmental	Social Interaction	Internal Mediation
Prior Knowledge		0.560	0.716	0.744	0.631	0.548
Multiple Resources	0.560		0.721	0.655	0.778	0.695
Action/ Reflection	0.716	0.721		0.804	0.847	0.791
Learning is Developmental	0.744	0.658	0.804		0.735	0.707
Social Interaction	0.631	0.778	0.847	0.735		0.813
Internal Mediation	0.548	0.695	0.791	0.707	0.813	

Correlations appear particularly strong between action/reflection and social interaction (.847), between action/reflection and learning as a developmental process (.804) and between social interaction and internal mediation (.813). An examination of the descriptors under each principle (See the Observation Protocol in Appendix 9) indicates that there were a number of commonalties across these principles: The teacher created a learning situation in which students were actively and autonomously engaged in multiple activities. The activity was complex as students wrestled with problem solving activities or answer open-ended questions. Finally, there was an element of choice present in the curriculum allowing for greater student autonomy.

What picture do such correlations paint? It appears, based on year two classroom observations, that constructivist learning environments allowed students to work together cooperatively and collaboratively, that students were actively engaged in their learning while reflecting in discussions among themselves or with the teacher about what they are learning. Though allowing for collaborative work among students, the activities were structured in such a way as to allow students to learn at their own pace and provide their own input into the creation of a final product or the negotiation of a particular problem. A factor then to a constructivist learning environment appeared to be the opportunity for reflection, collaboration with others, and activities that were developmentally challenging.

Thus far this report has examined what constructivist learning environments look like in general. The following section examines the second part of the research question one: what they look like in classrooms that are culturally and linguistically diverse.

Within the ATRL project 65 percent of students in the classrooms of participating teachers were non-white. Four schools had predominantly non-white populations: the urban Texas site (40 percent African American and 40 percent Hispanic), the Texas rural site and New Mexico site (90 to 100 percent Hispanic), and the Louisiana site (65 percent African American). White students comprised the remainder of the student body in

these schools. The Oklahoma cluster was comprised primarily of students who were American Indian, white, or both. The student body at the Arkansas site was almost entirely white.

Though schools may be integrated at an aggregate level, such integration is not always evident at the classroom level. For example, in one of the site schools, the special education student body was almost entirely African American. In this same school, honors classes were composed primarily of white students.

As can be seen in Table 3, there appeared to be a slight difference in the degree of constructivist approaches depending on the ethnicity of students. Classrooms that were all white or predominantly white (60 percent or more) appeared to adopt slightly more constructivist approaches (3.04 and 2.63, respectively, in year two) than classrooms that had an ethnic mix of students or that were composed entirely or almost entirely of students of color (a mean score of 2.43 for the latter two groups in year two). However, there are also indications that these higher scores may be more attributable to homogeneity than to race. For example, the more homogeneous a classroom appeared to be (in terms of this sample size that would mean for the most part white and Hispanic classrooms), the higher the constructivist approaches appeared to be.

Conversely, the more heterogeneous the classroom, as in the case of the "mixed" category in which 40 to 60 percent of the student body was white or non white, the lower the degree and frequency of constructivist approaches. In all but one category (internal mediation), these classrooms evidenced lower constructivist approaches. Yet these mixed classrooms also showed some of the largest gains in improvement in some approaches over the course of the two years of the project. For example, mixed classrooms experienced an increase of .91 in the use of prior knowledge, 1.49 in terms of action and reflection, and 1.33 in the area of internal mediation. Indeed, in the area of internal mediation there appears to be more parity among the five ethnic breakdowns of classrooms than is true of any other constructivist category.

In spite of such gains however, the gap between these mixed classrooms and classrooms with dominance by one or more ethnic group is evident, albeit minimal in some instances, and is especially pronounced when these mixed classrooms are compared to all white classrooms. Social interaction in all white classrooms for year two is 3.74, meaning that this approach is almost a frequent one, while in mixed classes it is 2.43, meaning that the opportunity for students to work together cooperatively and collaboratively is minimal. The "learning as developmental" category in white classrooms was 3.34, but 2.14 for mixed classrooms. Finally, in classrooms where all students are white, the mean for use of prior knowledge was 3.60, meaning it is almost a frequent practice, while in mixed classrooms the mean was 2.21, indicating that students' prior knowledge is elicited minimally.

There may be several reasons for this lag in the use of prior knowledge. First, the majority of ATRL teachers (58 percent) was white and thus did not share the ethnicity of their students (65 percent of whom were non white). Second, the majority of students

in ATRL project schools were poor.[5] Many lived in trailer parks, in inner city public housing, or in *colonias* along the Texas/Mexico border. Therefore, the majority of the teachers did not share their students' socioeconomic status and many did not live in the same neighborhoods as their students. Poverty is strongly linked to academic difficulties (Payne & Biddle, 1999), therefore many teachers may have found their poorer students more difficult to deal with. Indeed, informal conversations with teachers at two of the sites reveal that some teachers attached a certain pathology to their students' backgrounds, expressing the viewpoint that their students' family situations and socioeconomic status hampered both their behavior and their ability and willingness to learn. Therefore, it may have been likely that teachers didn't ask students what they knew because they thought that these students knew nothing about the subject at hand, or that the experiences that the students did have were not appropriate for a classroom setting. Diversity research (Greenfeld et al, 1995 as cited in Betsinger, Garcia and Guerra, 2000) highlights this conflict:

> Children bring to schools modes of interaction and behavior that reflect the invisible or hidden culture of the home and that are often in conflict with the invisible culture of the school, thereby creating problems for students and teachers alike.

For a student to open up and share what he/she knows requires that the student trust the teacher and feel safe. It may be that this safe atmosphere was lacking in some classes and that when the teacher did ask, students were less inclined to respond.

As illustrated by Table 3, by year two those classrooms exhibiting a higher use of prior knowledge had an all white or all non-white (in most cases Hispanic students) student composition. For the most part both the students and teachers in these classrooms shared the same ethnic identity. Therefore, it may have been easier for these teachers to elicit prior knowledge from students who looked like them, possibly shared similar cultural backgrounds, or lived in the same communities. Past data analysis[6] seemed to indicate that when teachers and students shared the same ethnicity/race that more constructivist approaches, including prior knowledge, were evident.

[5] Poverty at the school level is determined by the number of students receiving free or reduced lunches. In four of the six sites—the Texas sites, the New Mexico site, and the Louisiana site—this percentage varies from 75 to 100 percent. In the Arkansas and Oklahoma site, the percentage is 50 percent and approximately 70 percent, respectively.

[6] Analysis of 1999 data with a larger universe of teachers.

Table 3: Mean of Constructivist Principle by Student Ethnicity

Constructivist Principle	Year	Score*	All White (100%)	Mostly White (61%-99%)	Mixed (40%-60% white)	Mostly Students of Color (61-99%)	All Students of Color (100%)
Prior Knowledge	Baseline	Mean	2.7	2.22	1.3	2.13	2.56
		STD	1.08	1.19	0.280	0.871	0.863
	Year One	Mean	3.23	2.47	1.54	2.28	2.53
		STD	0.988	1.22	0.494	1.05	1.09
	Year Two	Mean	3.6	2.96	2.21	2.77	3.17
		STD	0.615	0.727	1.09	0.829	0.918
Increase 1998-2000			**0.9**	**0.74**	**0.91**	**0.64**	**0.61**
Multiple Resources	Baseline	Mean	1.8	2.06	1.4	1.65	1.62
		STD	0.777	0.664	0.543	0.565	0.476
	Year One	Mean	3.17	2.48	2.32	2.07	2.44
		STD	0.578	0.984	1.01	0.892	0.913
	Year Two	Mean	3.36	2.98	2.19	2.75	2.59
		STD	0.833	0.847	0.863	0.915	0.853
Increase 1998-2000			**1.56**	**0.92**	**0.79**	**1.1**	**0.97**
Action/Reflection	Baseline	Mean	2.75	2.79	1.48	2.03	2.57
		STD	1.2	1.12	0.814	0.902	0.931
	Year One	Mean	3.65	2.67	2.53	2.54	2.87
		STD	0.937	0.665	0.92	1.24	1.08
	Year Two	Mean	4.24	3.86	2.97	3.34	3.24
		STD	0.709	0.627	1.19	0.854	0.848
Increase 1998-2000			**1.49**	**1.07**	**1.49**	**1.31**	**0.67**
Learning as Developmental	Baseline	Mean	2.19	2.16	1.75	1.86	2.3
		STD	0.932	1.01	0.935	0.84	0.763
	Year One	Mean	2.6	2.1	1.75	1.93	2.15
		STD	0.759	0.639	0.612	0.868	0.805
	Year Two	Mean	3.34	2.68	2.14	2.43	2.58
		STD	0.595	0.803	0.885	1.31	1.29
Increase 1998-2000			**1.15**	**0.52**	**0.39**	**0.57**	**0.28**
Social Interaction	Baseline	Mean	1.91	2	1.47	1.94	2.28
		STD	0.618	0.904	0.567	0.69	0.814
	Year One	Mean	2.93	2.02	2.61	2.02	2.48
		STD	1.05	0.992	1.38	0.858	1.05
	Year Two	Mean	3.74	3.05	2.43	3.02	2.95
		STD	0.714	0.935	1.31	1	0.907
Increase 1998-2000			**1.83**	**1.05**	**0.96**	**1.08**	**0.67**
Internal Mediation	Baseline	Mean	1.72	1.91	1.25	1.54	1.61
		STD	0.784	0.71	0.433	0.667	0.723
	Year One	Mean	2.14	1.67	2.2	1.81	2.07
		STD	0.626	0.5	0.968	0.92	0.879
	Year Two	Mean	2.99	2.91	2.58	2.7	2.51
		STD	0.713	0.641	1.29	0.837	0.849

Increase 1998-2000	1.27	1	1.33	1.16	0.9
Overall Mean Score Year Two	3.04	2.63	2.07	2.43	2.43

*STD is the Standard Deviation.

A Funds of Knowledge questionnaire (See Appendix 15) was administered to participating ATRL teachers to determine how they bridged cultural gaps with their students and how they used their knowledge of students' culture in helping them glean students' prior knowledge. The "Funds of Knowledge" concept was originally designed by Moll et al (1992) for application to elementary Hispanic students and their families. A researcher in this field informed ATRL staff that this was the first time the Funds of Knowledge concept had been applied to teachers of all grade levels in a broader ethnic population. Responses to the questionnaire were cross-tabulated with scores on the observation protocol in order to examine the relationship between teachers' use of prior knowledge and use of students' funds of knowledge.

Results of this analysis, however, shed little light on the seeming disparity between the use of prior knowledge in all white and mixed classrooms. According to teachers' self-reports on the survey, the majority appeared to know little about their students' background. For example, 91 percent did not answer when asked if students spoke another language at home. Ninety-seven percent did not answer when asked to give the parents' primary occupation. Only 26 percent had ever visited a student's home. Though 54 percent of teachers reported having attended some sort of diversity training, there was not much evidence that teachers drew upon students' diverse backgrounds in their classes.

For the most part then teachers appeared not to avail themselves of students' funds of knowledge. However, those that did at some level tap into students' cultural experiences tended to be those teachers who were ranked higher in constructivist approaches. As such there appears to be a very tenuous link between the degree of constructivist approach and a teacher's use of students' "funds of knowledge" as Table 4 indicates.

Table 4: Constructivist Approaches and Teacher Use of Student's Culture

	Low	Medium-low	Medium-high	High	Total
Teacher incorporates some other aspect of student culture (study of heroes, foods, celebrations)	11	13	23	25	72

Although these teachers made an attempt to utilize some aspect of students' culture into the classroom, such use appeared minimal and involved very visible, or superficial aspects of culture, such as foods, celebrations, or heroes. Banks (1993) refers to this level of multicultural integration as the "contributions approach" (p. 13)—the most rudimentary level of content/curriculum integration in his methodology. Higher level approaches where students are permitted to view concepts and issues through the prism of their own culture (referred to by Banks as the "transformation approach") were not reported. Aside from the concessions to the discrete cultural elements mentioned previously, only 13 teachers reported having students write about

themselves, seven teachers reported using popular celebrations in their classrooms, and six reported that students discussed their cultural background in class.

However, based on ATRL observations in these classrooms, these incidences of use appear exceptionally low. This may be a result of the survey design. Because the questionnaire was so open ended, teachers may have under-reported their use of students' funds of knowledge because they were unaware of what activities constituted an "aspect of culture," the term used in this particular question. In addition, a number of teachers reported that as they completed the survey after the end of the school year, they could not remember information they needed to answer some of the survey questions.

Summary

There was no one model of a constructivist learning environment. Rather there were four prototypes varying in both the intensity and frequency of constructivist approaches: low, low-medium, high-medium and high. Further, since so much of learning and so many instructional approaches focus on the internal thought processes of the learner, not all constructivist approaches could be captured by research instruments.

Nevertheless, learning environments grounded in constructivist approaches appeared to share a number of common characteristics. Students were more active, autonomous, and highly engaged with the subject matter or learning content. Oftentimes they worked collaboratively with peers to solve a problem, presented findings or completed a project. Often, but not always, such tasks were accomplished with the use of technology. In such an environment the curriculum was structured in such a way to allow students greater flexibility and authority in terms of their own learning. The teacher, while an integral part of the classroom, acted more as a producer, rather than a director, setting up the learning situation and then allowing students to use the means necessary to arrive at a certain end.

Quantitative and qualitative analysis of data gathered by the ATRL project indicated that classrooms generally shifted toward more constructivist approaches. Even if classrooms did not shift across clusters (low, medium-low, medium-high, high) or remained within a designated cluster, for the most part their mean scores increased over the project. The next section analyzes this change over time and some possible reasons for these changes.

Findings: Research Question Two

How can teachers be assisted in developing constructivist learning environments supported by technology?

Introduction

The *Applying Technology to Restructuring and Learning* project began with certain assumptions about elements that would be necessary to assist teachers in developing constructivist learning environments supported by technology. These assumptions were based on our previous experiences in supporting change in general, in helping teachers learn to use technology (Dimock & Rood, 1996), and from a review of the literature (Boethel & Dimock, 1999). Specific criteria for site selection, as described previously, included criteria based on these assumptions. In particular, each site was required to have a commitment from campus and district administrators and from classroom teachers to support the creation of technology-rich learning environments that employed instructional approaches consistent with constructivist learning theory. It was required that their district's technology plan had a financial commitment for ongoing purchase, support and maintenance of technology. Each site was also required to have an on-site technology coordinator or a contract with a local service provider. Administrative support required provision of time on the school calendar for professional development sessions as well as assistance and support for teachers as they worked to change their instructional practice. An appointed school or district staff member was also asked to serve as a co-developer who would work with the ATRL staff for setting up and organizing professional development sessions.

This conscious effort to minimize many of the barriers noted in SEDL's previous work and cited in the literature, did not, however, create "perfect sites." Each site experienced its own challenges in continuing to meet the criteria specified for participation and will be described in depth in the following sections.

Data sources. Four different data sets were analyzed to answer the question "How can teachers be assisted in developing constructivist learning environments supported by technology?"

1. *Observation data.* Analyses of observation data included comparisons across the categories on the Classroom Observation Protocol (Appendix 9) to document which practices modeled during professional development may have transferred into classroom practice. Comparisons of these categories and comparisons of observation data and the self-assessment of computer skills with field notes were made to inform any differences in support required at various grade levels.

2. *Computer skills.* The baseline Computer Skills Checklist (Appendix 12) was compared with subsequent administrations to look for relationships between teachers who have technology skills and high constructivist practice. The Computer Skills Checklist

results were compared to professional development session offerings to identify computer skills increase as a result of professional development sessions.

3. *Field notes, site reports, and interview data.* Analysis of field notes and site reports provided information regarding the impact of professional development. Analysis of videotaped teacher interviews and the in-depth case study interviews helped reveal the personal process of change that individual teachers dealt with when participating in an innovation and what influenced those changes. Interviews allowed teachers to discuss their fears and frustrations as well as successes and milestones in transforming their practice into constructivist classrooms supported by technology.

4. *Questionnaires.* The *Teaching, Learning, and Computing: Teacher's survey* (Becker & Anderson, 1998) (Appendix 11) provided an additional profile on each teacher and the group as a whole. This instrument asked teachers what they believed about teaching and learning and what support they needed to help them become the teachers they want to be. One hundred and two project participants completed this survey. These data were compared to observation data as well. As the participating teachers had received professional development designed to assist them in creating CLEs, one might hypothesize that rankings on constructivist practice and use of technology would be higher for ATRL teachers than for teachers in the national sample.

Findings

Analysis of observation protocol data to document change in practice. As noted in section (See Figure 1, page 26) most teachers shifted their practice toward more constructivist approaches. This section will examine that change by cluster.

Two tables accompany the description of each of the clusters—low, medium-low, medium-high and high. The first table shows the percentage of classrooms in each cluster from baseline to year two. The individual classrooms that composed each of these clusters and the changes from year to year.

The second table tracks the changes in mean scores in constructivist approaches for those classrooms rated in a particular cluster in the ***baseline*** year. Such analysis makes it possible to track movement of the original clusters of classrooms. Again, it is important to note that these classrooms *did not remain fixed* in a particular cluster, so this table does not represent the mean score of all classrooms ranked as low, medium-low, medium-high, or high constructivist for subsequent observations. Rather, the table represents the mean score over three observations for those who were ***originally*** placed in the low, medium-low, medium-high, or high category.

Low Constructivism

Table 5 - Low Constructivism		
Baseline	**Year 1**	**Year 2**
47.2%	16.7%	15.3%

In Table 5, baseline formal classroom observations revealed that 47.2 percent of all classrooms in the sample of 72 classrooms fell into the low constructivism category. By the end of year one that number had fallen sharply to 16.7 percent and by project-end to 15.3 percent.

The seeming flat decline in low constructivist teachers from mid-project to year two may be explained in part by the confluence of a number of events in two of the project schools. First, at the beginning of year two, one site school lost both its principal and assistant principal, both of whom actively supported their teachers' shifting toward more constructivist, technology-integrated approaches and were more familiar with the ATRL project, having actively worked to bring it to their school. They were replaced by two novice administrators, one of whom was not familiar with constructivist approaches and whose emphasis was on improving standardized test scores. The school struggled with discipline and teachers felt forced to devote much of their class time to enforcement rather than teaching.

Second, this same school was redistricted, losing some of its youngest, most innovative teachers (including four from the ATRL project) and losing many of its high achieving students. The latter occurrence in particular appeared to create an even greater emphasis on the importance of test preparation. With all of these changes, it was reportedly difficult for many teachers to conduct the sort of student-centered activities they had in year one.

The second project school was labeled as "low performing" after year one and was placed on academic probation. During the second year of the ATRL intervention emphasis in the school was on improving standardized test scores. Many of the ATRL project teachers were dismayed that this new emphasis detracted from their focus on technology integration and student-centered approaches.

Such circumstances are important to note since 25 of the 72 teachers in the final data set were located at both of these sites. Since this total represents 35 percent of all sample teachers and nearly 100 percent of all sample middle school teachers, the change in practice wrought by such circumstances undoubtedly impacted the overall scores for the entire data set.

There were also a number of general factors for this flat rate of decline. Change literature documents the existence of "resistors," participants who for a myriad of reasons cannot or will not change their practice. Certainly within the ATRL project, there were a number of resistors. Why then would these individuals voluntarily become part of a program that aims to change instructional practice? For many of these teachers, the lure seemed to be the technology component. Many of these resistors may have entered the project believing it was primarily a technology training project and were not interested in the instructional component. There were also some teachers who were enrolled by their principals in hopes of improving their general teaching practice.[7]

[7] Per field notes and informal interviews with teachers and principals.

Another reason for this flat rate of decline in low constructivist environments between years one and two may be attributable to the normal learning curve. For most project teachers, the information presented in year one staff development was new and adaptable to their practice. They therefore implemented such change in their classroom practice. By year two, however, it is possible that they may have "stalled out," having changed as much as was possible for them.

Finally, it is also possible that a number of teachers became satisfied with the change they achieved during year one. Therefore their classroom practices remained essentially fixed.

Table 6 - Change in Mean Score of Baseline Low Cluster		
Baseline	Year 1	Year 2
1.42	2.07	2.64

Overall, how did these originally low constructivism classrooms fare over the two years of the ATRL project? Table 6 shows that while the mean score of constructivist practice for the classrooms designated as "low constructivist" in the baseline year was 1.42, by the end of year two the mean score for those same classrooms had risen to 2.64. It is important to remember that not all these classrooms remained in the "low constructivism" category throughout the two years of the project.

Medium-low Constructivism

Table 7 - Medium-low Constructivism		
Baseline	Year 1	Year 2
18.1%	18.1%	23.6%

As Table 7 illustrates, 18.1 percent of classrooms were identified as low-medium constructivism during baseline observations. Though that number remained fixed in year one, by year two it had increased to nearly 24 percent. In part that increase can be explained by the circumstances mentioned above about one of the project site schools.

As with low constructivist classrooms, the overall mean scores of classrooms identified during baseline observations as medium-low constructivist (Table 8) increased over the course of two years, even surpassing the mean score of those identified as medium-high during baseline observations. While the classrooms designated medium-low constructivist in baseline observations had an overall mean score of 2.23, by the end of year two, those same classrooms (not all of whom remained in the same category) had an overall mean score of 3.15 and many had migrated out of the "medium-low" category. This is illustrated in greater detail in Tables 14, 15 and 16 on pages 43-44.

Table 8 - Change in Mean Score of Baseline Medium-low Cluster		
Baseline	Year 1	Year 2
2.23	2.75	3.15

Medium-high Constructivism

Table 9 - Medium-high Constructivism		
Baseline	Year 1	Year 2
29.2%	31.9%	31.9%

As shown in Table 9, the number of medium-high constructivist classrooms changed by only 2 percent over the two years. In 1998, 23 classrooms (29.2 percent) were designated as medium-high constructivist.

As Table 10 indicates, the overall mean score of these 23 classrooms was 2.25. By the end of the project, the same 23 classrooms (not all of whom remained medium-high constructivist) had a mean score increase to 2.95 and many classrooms migrated out of this medium-high category, while others moved into the category. This is illustrated in greater detail in Tables 14, 15 and 16 on pages 43-44.

Table 10 - Change in Mean Score of Baseline Medium-high Cluster		
Baseline	Year 1	Year 2
2.25	2.57	2.95

High Constructivism

Table 11 - High Constructivism		
Baseline	Year 1	Year 2
5.6%	33.3%	29.2%

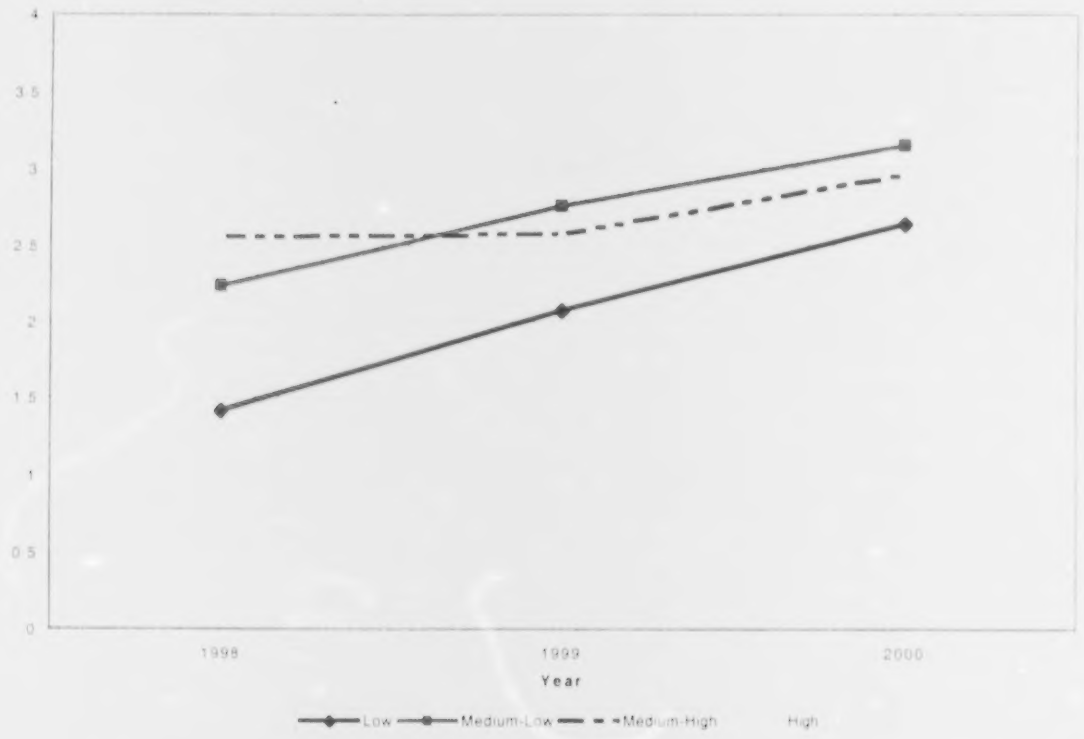
In the baseline classroom observation, the number of classrooms observed as high constructivist was 5.6 percent as shown in Table 11. By year one this number had increased six fold to 33.3 percent. By year two the number had decreased slightly to 29.2 percent of all classrooms observed. As mentioned previously in this section, such a drop off is most likely the result of contextual events particular to two schools. Additionally in another of the sites, students were preparing for external state tests and many classes, normally observed informally as more active and focused on a particular unit of study or project, were preparing for state testing during the formal observation.

The 5.6 percent of classrooms originally designated as high constructivist in baseline observations had an overall mean score of 3.45 as shown in Table 12. By the end of the project, the same classrooms (not all of whom remained high constructivist) increased to 3.56. Many of these original high constructivism classrooms were already using student-centered approaches prior to the project but with little or no technology. Because of the introduction to new types of technologies, many of these teachers began integrating technology in a much more holistic fashion. This is illustrated in greater detail in Tables 14, 15 and 16 on pages 43-44.

Table 12 - Change in Mean Score of Baseline High Cluster		
Baseline	Year 1	Year 2
3.45	3.00	3.56

Figure 2 illustrates the changes in these four clusters of classrooms over the two years of the ATRL project.

Figure 2: Change in Cluster Mean Scores



While the analysis above examines the changes in classrooms based on an aggregate of constructivist descriptors, Table 13 (page 42) documents these data in a disaggregated form. The table illustrates changes in scores on constructivist descriptors over the project. Those classrooms that were on the lower end of the constructivist spectrum in the baseline year experienced the greatest positive change in terms of constructivist approaches. In fact, as the classroom ascended the constructivist scale (from low to high) the amount of increase diminished. Thus, the more "constructivist" the classroom, the lower the amount of change; the less constructivist, the greater the amount of change.

The rationale for such a pattern seems to be fairly intuitive. Lower constructivist classrooms had more room to grow and did so. However, the flat and in some cases

negative growth among high classrooms from the baseline year to year two may be the result of two "ceiling" effects. First, because these classrooms were already high to begin with in terms of constructivist practices, they showed less growth because they didn't have as far to go as their counterparts in other clusters. Second, because of the finite structure of the observation protocol, ranging from scores of one to five, the observation protocol could not capture the amount of growth evidenced by these high constructivist classrooms.

Table 13: Mean of Constructivist Approach by Year

Constructivist Principle	Year	Low	Medium-low	Medium-high	High
Prior Knowledge	Baseline	1.52	3.05	2.24	3.93
	Year One	1.95	3.13	2.82	3.36
	Year Two	2.55	3.35	2.89	3.64
Change 1998-2000		**1.03**	**0.3**	**0.65**	**-0.29**
Multiple Resources	Baseline	1.35	1.72	2.13	2.71
	Year One	2.27	2.5	2.38	3.29
	Year Two	2.5	2.91	2.76	3.25
Change 1998-2000		**1.15**	**1.19**	**0.63**	**0.54**
Action/Reflection	Baseline	1.47	2.72	3.09	4.62
	Year One	2.42	3.19	3.23	3.31
	Year Two	3.14	3.52	3.46	4.63
Change 1998-2000		**1.67**	**0.8**	**0.37**	**0.01**
Learning as Developmental	Baseline	1.48	2.37	2.51	3.78
	Year One	1.76	2.55	2.38	2.69
	Year Two	2.27	3.17	2.89	3.72
Change 1998-2000		**0.79**	**0.8**	**0.38**	**-0.06**
Social Interaction	Baseline	1.45	2.12	2.78	3.22
	Year One	2.24	2.82	2.79	2.91
	Year Two	2.79	3.27	2.99	3.28
Change 1998-2000		**1.34**	**1.15**	**0.21**	**0.06**
Internal Mediation	Baseline	1.22	1.41	2.51	2.45
	Year One	1.76	2.3	2.31	2.45
	Year Two	2.6	2.7	2.72	2.85
Change 1998-2000		**1.38**	**1.29**	**0.21**	**0.4**

Table 13 examines the change in mean scores per constructivist approach *within* classrooms over time. Tables 14, 15 and 16 track the movement of clusters or categories of project classrooms over time. As mentioned previously, the primary rationale for clustering classrooms was to classify these classrooms according to a set of common practices, describe characteristics of each, and discern the movement of these categories over the course of the project. Since the ATRL project sought to shift low constructivist classrooms into high constructivist learning environments, both ends of that continuum are examined.

As illustrated in Table 14, from 1998-1999, of all the classrooms designated low constructivist in 1998, only 32.4 percent were still low in 1999. Twenty-nine percent had become medium-low constructivist; 17.6 percent were classified as "medium-high" and

more-than one out of five (20.6 percent) were now considered high in their use of constructivist approaches.

On the other end of the continuum, of all the classrooms that were considered "high" in constructivist approaches in 1998, 75 percent remained high the following year in 1999, while 25 percent moved into the medium high category.

Table 14: Change in Constructivist Approaches 1998-1999

Year	1999	Low	Medium-low	Medium-high	High	Total
1998	Low	32.4	29.4	17.6	20.6	100
	Medium-low			57.1	42.9	100
	Medium-high	7.7	23.1	30.8	38.5	100
	High			25	75	100

Totals are rounded to equal 100.

The 1999-2000 school year was a difficult one for two ATRL project site schools. As mentioned earlier in this section, one school lost two administrators who were very supportive of using constructivist approaches, as well as a number of innovative teachers and high performing students. Another school was deemed "at risk," and instructed to improve its state test scores or risk being taken over by the state.

In some instances, these contextual upheavals had classroom repercussions as reflected in Table 15. Of all the classrooms considered "low" in constructivist approaches in 1999, 41.7 percent still remained low in 2000, while a smaller number (16.7 percent) had migrated into the high category. On the other end of the continuum, of the teachers considered "high" in constructivist approaches in 1999, only 41.7 percent remained "high" (in contrast to 75 percent the year before). The remaining 58.3 percent had slipped into "lower" classifications: 33.3 percent into the medium-high category, approximately 21 percent into the medium-low category and 4.2 percent into the low constructivism category.

Table 15: Change in Constructivist Approaches 1999-2000

Year	2000	Low	Medium-low	Medium-high	High	Total
1999	Low	41.7	8.3	33.3	16.7	100
	Medium-Low	23.1	7.7	38.5	30.8	100
	Medium-High	8.7	26.1	26.1	39.1	100
	High	4.2	20.8	33.3	41.7	100

Totals are rounded to equal 100.

Table 16 illustrates overall change from baseline observations in 1998 to year two in 2000. Overall in terms of the ATRL project, the 2000 observation data reflects a drop in the number of "original" (baseline) low constructivist classrooms—from 32.4 percent in 1999 to 26.5 percent.

Of the teachers who were considered "low" in constructivist practices in baseline observations, by project-end 26.5 percent still remained low in constructivist

approaches. Nearly 59 percent of these "low" classrooms had become either medium-high (32.4 percent) or high (26.5 percent) constructivist learning environments. Similarly, of those categorized as "medium low" in baseline observations, over three-quarters (76.2 percent) had moved into the "medium high" or "high" constructivist ranges by project end.[8] Of those classrooms identified as medium-high in baseline observations, approximately 69 percent remained medium-high or moved into the "high" category.[9] Finally, of the classrooms identified as "high" in 1998, 75 percent remained high while 25 percent shifted into the medium low category. These classrooms are located primarily at two schools and this negative shift is attributable in part to increasing discipline problems at the school and a new administration that emphasized preparation for state tests.[10]

Table 16: Change in Constructivist Approaches 1998-2000

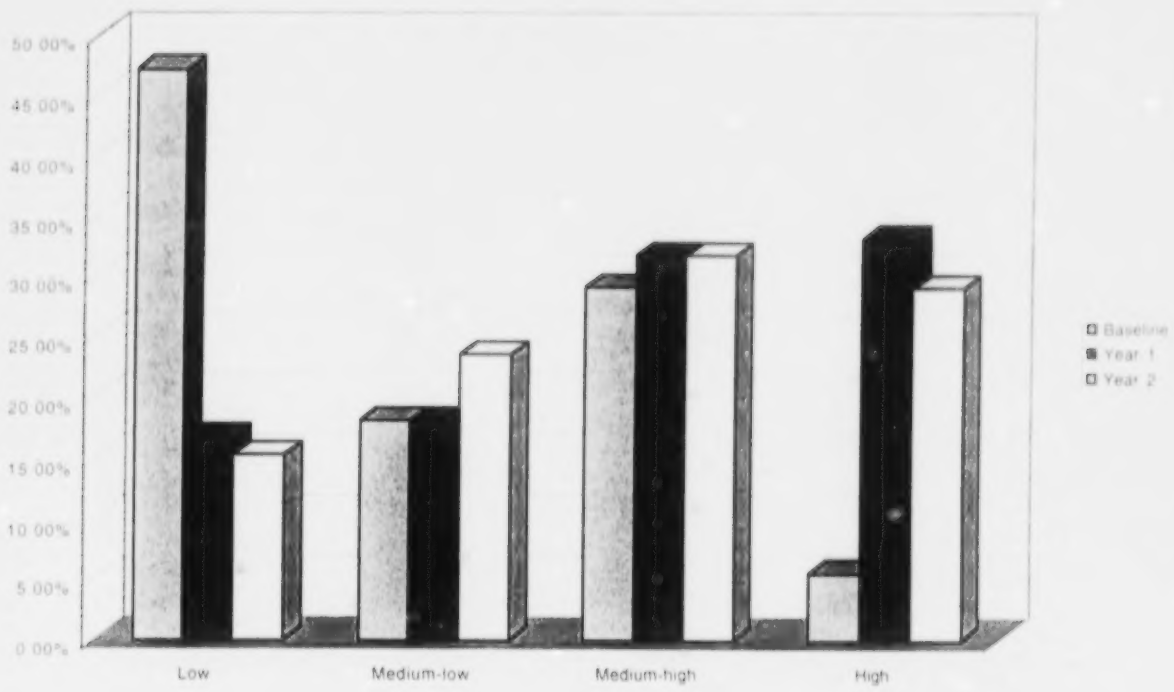
Year	2000	Low	Medium-low	Medium-high	High	Total*
1998	Low	26.5	14.7	32.4	26.5	100
	Medium-low		23.8	33.3	42.9	100
	Medium-high	15.4	15.4	38.5	30.8	100
	High		25		75	100

Totals are rounded to equal 100.

Figure 3 illustrates the changes in the clusters over time.

[8] 33.3 percent "medium-high" and 42.9 percent "high."
[9] 38.5 percent "medium-high" and 30.8 percent "high."
[10] This comment is based on informal interviews with teachers.

Figure 3. Change in Classroom Clusters



Barriers and Support Structures for Change

Though this section has explained some circumstances and change factors at individual project site schools, there are broader factors that seemed to assist teachers in shifting from more traditional to constructivist approaches. Themes emerging from analysis of field notes and interviews included teacher attitude, professional development opportunities, access to and use of technology, proficiency in technology, administrative support, technical support, teachers' peer support, critical mass, control issues, time, external pressures, teacher expectations, and teacher commitment. Each will be examined in greater detail.

Attitudes

Several factors that seemed to influence change in classroom practice were related to attitudes.

Willingness to change. A desire and willingness on the part of participant teachers to change their pedagogical practice seemed an important factor. It was important that they recognized a need to change—either because of the belief that students learn better in a different type of setting or because of imposed mandates from the district or

administration. Informal and formal data gathering (both quantitative and qualitative) indicated that those teachers who reported a belief that students learn better in a more student-centered, technology rich environments molded their practice to accommodate such a belief. Teachers also seemed willing to "buy in" to such pedagogical shifts if they saw their colleagues successfully implementing student-centered, technology-integrated practices with students. This was particularly true if teachers shared the same students, and most particularly with so-called difficult or under-achieving students. At an ATRL professional development session, when teachers were sharing student projects, teachers were heard to exclaim, "[Student X] did that?!"

Rogers (1993) identifies those undergoing change as belonging to one of five adopter types: innovators, early adopters, early majority, late majority, and laggards. Field notes and discussions with teachers revealed that even though innovators were most likely to be willing to change, an innovator was sometimes **not** the best model for other teachers wishing to change practice. In some of the site schools, those teachers (innovators) most willing to embrace technology-integrated, constructivist approaches, or who were already employing such practices at the project's start, were deemed too innovative, different, or talented and, therefore, not able to be emulated. Instead, teachers appeared to be willing to follow the example of the "early adopters." Rogers describes these individuals as "the embodiment of successful and discrete use of new ideas" (p. 249). Field notes indicate that these early adopters were considered reliable barometers of the validity of innovations and also tended to be faculty leaders in other areas.

Control. A desire to maintain control appeared to be one of the biggest impediments to changing practice. Indeed, in discussing the greatest obstacle to shifting pedagogical practice, most teachers mentioned their own difficulty in giving up control. It appeared that this control issue dealt mainly with classroom discipline and the deep-seated fear that any loosening of the teacher's grip would result in chaos. Broadly, project teachers appeared to have adopted four strategies in dealing with the control issue. Those who reported a belief that "constructivism" equaled an abdication of authority and discipline did not adopt constructivist approaches. Others came to see "control" as less a monolithic and absolute term and adopted a more à la carte approach. While maintaining strong classroom discipline, they stopped micro-managing students or allowed students a greater voice in some areas (e.g., product creation and appearance) while retaining sole authority in others (e.g., grading procedures, discipline). A third group decentralized their classroom to a very large degree, giving students near equal decision-making power in terms of grading procedures, units of study, and other components of their learning. On the other hand, a fourth group thought "constructivist practices" translated as "no control." They offered few instructions or guidelines for some projects and as a result, students in these classrooms appeared either confused or disinterested about doing their assignments. These teachers justified their classroom practice by saying that they were using "constructivist practices."

Patterns of control seemed to increase in those schools where an emphasis was placed on improving scores on district or state standard testing. In the second year of the project, observations showed some teachers returning to more teacher-centered instruction for district or state test preparation with desks in rows and students doing more individual work and drill and practice types of activities.

Teacher expectations of students. Teacher expectations sometimes inhibited attempts to shift practice. In one site school, shifts in practice appeared to be influenced by teachers' stated beliefs that technology-integrated, constructivist approaches could only be successfully undertaken in "honors" classes, which in this particular context meant classes composed of predominantly or exclusively white students. "Regular" classes in this school tended to be more racially diverse. Though teachers in the school did employ more constructivist approaches with these classes, they did not appear to do this to the extent or degree as occurred with honors classes.

Commitment to technology integration. Commitment from the individual teacher to take on the use of technology also appeared important to the changes in practice made by individual teachers. The following describes teachers by their level of commitment to integration of technology over the course of the project.

No Attempt
These teachers made no attempt to either use constructivist practices or technology. This group expressed several reasons for their lack of change: "There isn't enough time," "My students can't do it," "Technology can't help me," were common statements from this group of teachers. This group appeared to have moderate to low computer skills.

Coasting
This group of teachers appeared happy with their practice, their use of technology, and/or their classroom lessons. While they may have been integrating technology in the classroom to support traditional practices, they often saw no reason to try anything new.

Taking Time
Teachers in this group cautiously tried out some technology and changed their teaching practice in minor ways. They seemed to be "testing the waters" and would abandon their effort if it not successful the first time. These teachers needed frequent support and encouragement in their efforts.

Striving
These teachers were working in multiple ways to change what they were doing. They wanted to change but found it difficult to use the technology in the classroom or learn new computer skills. This group appeared to be trying to learn new computer skills and incorporate constructivist ideas at the same time. They were very conscientious in their efforts and did not give up easily.

Taking Off
These teachers combined their knowledge of computers, changed classroom management techniques, and created uses for computer technology. They liked and encouraged change in their teaching. Entering this project they either had strong computer skills or were already using constructivist practices in their classrooms.

Professional development. Analysis of the changes in teachers' practice indicated that changes were based in part on the professional development sessions provided for them. Site reports and classroom observations showed that teachers were able to use the learner-centered and technology management strategies that were modeled in various professional development sessions.

Project teachers received 72 hours of professional development over the course of the project. Data analysis revealed a statistically significant relationship between teachers' shift in practice and the amount of professional development attended in year one of the project. Though there was also a relationship between change in practice and hours of staff development in year two, this relationship was not statistically significant. This disparity in significance may be the result of a steep learning curve in application of constructivist practices supported by technology that teachers had to accomplish, followed by the need to sustain those changes in year two.

An aggregated comparison of baseline and year two data from the observation protocol reveals that teachers overall changed practice and adopted more constructivist approaches. A comparison of means from baseline and final observations is presented in Table 17. A score of one on a descriptor on the observation protocol indicates that the constructivist approach was not evident during the observation. A score of five indicates that it was evident throughout the entire class period.

Table 17: Change in Constructivist Approaches: Baseline to Year Two

Principle	Baseline Observation	Year Two Observation	Incremental Increase
Prior Knowledge	2.23 (.947)	2.91 (.886)	0.68
Multiple Tools & Resources	1.67 (.586)	2.71 (.886)	1.04
Learning is Active & Reflective	2.30 (1.02)	3.39 (.876)	1.09
Learning is Developmental	2.06 (.855)	2.73 (.806)	0.67
Social Interaction	1.98 (.742)	2.99 (.986)	1.01
Internal Mediation	1.58 (.680)	2.67 (.863)	1.09
Average Practice	**1.96 (.647)**	**2.9 (.744)**	**0.94**

Improvement for each paired principal is significant at a confidence level of 95% except for social interaction (.182) and internal mediation (.905)

Those descriptors on the observation protocol evidencing the highest degree of change were also the types of approaches most frequently modeled in the professional development sessions, As Table 17 indicates, over the course of two years, teachers shifted practice to a more constructivist approach. Factors related to these changes in practice are discussed in greater detail below.

Learning is active and reflective

The largest two-year shift in the observation protocol principles or categories was in the area of action and reflection (2.30 to 3.39) and internal mediation (discussed below). All staff development sessions had an active component—where teachers engaged in a learner-centered, technology-integrated activity. The activity was followed by a reflective component, in which teachers discussed or wrote about the activity, its transferability to their classroom, the merits and demerits of such an approach, and modifications they would make in doing something similar with students. Thus, teachers were given time to discuss their progression as learners in terms of both constructivist approaches and technology use.

Learning is internally mediated

Equal to the shift in active and reflective learning was the principle of internal mediation (1.58 to 2.67). This shift may be explained by the structure of the ATRL professional development sessions. Though teachers worked collaboratively, some teachers worked alone if they so desired. All activities were structured to allow autonomy and initiative so that learners could raise issues to be explored, solve problems, and design the method that best showcased their findings. Further, as noted above, each activity culminated with a reflection component, where among other things, teachers shared what the learning meant to them personally.

Multiple tools and resources

Another large shift was in the area of teachers' use of multiple tools and resources (1.67 to 2.71). This shift may have been influenced by a several factors, including professional development. Though many teachers previously had computers in their classrooms, some were unaware of how to use them or how to use more than one type of software application. As one teacher reported:

> I have always wanted to see my classroom with the computers integrated, but I never knew how. How in the world am I going to do that, when I don't know the computer myself? With SEDL's help, I've learned so much, and I'm not at all tentative to get behind the computer and try something new.

Social Interaction

In addition, professional development sessions emphasized the role of social interaction (a change of 1.96 to 2.99 on the observation protocol). Most teachers were in constant collaboration and communication with their peers. As one teacher commented about ATRL's professional development, it reminded her that "learning is a team sport." Teachers reported that this emphasis on social interaction during the professional development sessions resulted in greater collaboration among project teachers at their

school. The result of such collaboration appeared to be the creation of learning communities at many of the site schools. As one project teacher reported, "We (the teachers) became a community of learners and we shared this with our students so that they too became a community of learners."

Models for managing classrooms with technology. ATRL professional development activities focused on increasing teacher comfort levels with new technologies and stressed minimal proficiency, i.e., that one did not need to be an "expert" with a particular piece of software in order to use it with students. Consequently, teachers felt more comfortable allowing students to access a software tool that hadn't been introduced in an ATRL professional development session.

Teachers also expressed a major concern regarding classroom management when using technology and constructivist approaches. A fear of "letting go" of control in the classroom and a fear that chaos would ensue were expressed by a number of teachers. To assist teachers with this concern, the professional development sessions introduced three models of classroom management. For a detailed description of these models, see pages 4 and 5 this report.

The Active Learning Environments model was presented in the early professional development sessions. This model was one ATRL staff believed would be more useful for elementary teachers who often use learning centers, but not as useful for middle and high school teachers. However, several middle school teachers in the ATRL project were able to employ this model successfully in their classrooms. A team of five middle school teachers used this approach for a cross-disciplinary project collaborative project. The reported that they had planned too many activities but also reported that student interest and energy were high and that they would definitely use this approach again on a much smaller scale. They suggested that "first timers" focus on a simple project and allocate time for advance planning and organization.

The Navigator Model was designed as a collaborative team effort that also promoted the learning of a new technology application. A number of teachers reported that the "no hands rule" of this model helped them resist taking control of the computer keyboard when they were helping students work on the computer. They also reported that this rule was beneficial for managing students who wanted to monopolize the computer in the classroom. By appointing students as "Navigators," they were more conscious of their behavior.

> The ATRL training taught us not to touch the mouse if you are trying to teach someone what to do. I catch myself with the kids at the computer, you automatically show them what to do. Just little things that we'd never thought of, that filters through all these things we're learning.

The Expert Model was used in several professional development sessions. Teachers reported that in their classrooms, student "experts" seemed to emerge. Those students with the interest and skills in using particular software identified themselves and were

eager to help other students. By allowing student technology experts to emerge, the teacher was freed from the challenge of having to master new technologies.

In addition to these management models, teachers were introduced to a variety of authentic data sources (i.e., census data and data from local chambers of commerce) about which they were unaware and which many subsequently used with students. Finally, the professional development activities in which teachers participated offered a variety of both computer and non-computer resources. Many teachers adopted and adapted the use of these data sources in their classrooms.

Due to constraints imposed by facilities and feedback from participating teachers, ATRL staff at one site school took a different approach in professional development sessions. Most sessions occurred in a computer lab setting and did not employ the technology management models described above or a learner-centered approach. Instead, those teachers experienced teacher-led activities in a computer lab setting with one person to a computer and all participants doing the same activity at the same time. Resulting observations showed that the teachers at this site appeared less willing and able to apply constructivist approaches in their own classrooms. They continued to use technology in a more traditional fashion. Unlike the other five site schools, teachers in this site were still expressing uncertainty about managing the limited computer classroom at the end of the project. In addition, overall attendance and engagement by these teachers was much lower than at other sites.

During the second year of the ATRL project, staff noted that teachers needs for professional development were diverging sharply. There were more individual requests for follow-up assistance with specific software applications and for help in developing ideas for classroom activities. Attendance and interest at all professional development sessions remained high during the second year, with the exception of one site, as noted above.

Professional development activities during year two continued to model learner-centered collaborative classroom strategies that emphasized managing a classroom with limited access to computers. Most teachers who started the program with low technology skills had increased their technology skills as reported on the Computer Skills Checklist (See Figure 4 on page 64). They reported that they were now able to carry out simple projects with their students in the classroom.

Professional development sessions during the second year also introduced more Internet based activities for the classroom, more advanced projects, and time during the sessions for designing classroom activities and refining activities teachers had employed in the classroom the previous year. The sessions in year two placed more emphasis on content and planning.

A comprehensive problem-based learning activity called "Managing Growth" and its related interdisciplinary activity called "Connections" were developed at the request of teachers at one of the site schools for an example of an interdisciplinary activity that involved team teaching. In both activities, teachers were asked to work together as community members to solve a problem situated in their home community. This

problem required use of their prior knowledge about the community and elicited a great deal of reflection about the changes that had taken place in the community over time. Multiple technology applications were used and the activity extended over two normal staff development sessions. These sessions also helped fulfill the need for a more advanced project for those teachers with advanced skills in both technology use and constructivist practice and was modified and used at other sites as well.

Effectiveness of professional development. The role of professional development was also evident in results of the *Teaching, Learning, and Computing Teachers' Survey (TLC)* (Appendix 11) administered to participating teachers. Results are consistent with the findings of other researchers (*Education Week*, 1999) who report that up to sixty percent of teachers who had eleven hours or more of basic technology skills training and curriculum-integration training say they feel "much better" prepared to use technology. In the case of this study, teachers received a total of 72 hours of professional development that included curriculum integration and included opportunities for building technology skills.

The TLC was administered to the project participants at the end of the second year of the project and results were compared with results from the random national sample. It was hypothesized that responses from teachers participating in the ATRL professional development would reflect positively the influence of professional development on their teaching practice and technology use. Although the sample size for analysis of observation data was 72 teachers, the sample size for the TLC survey is 102 teachers, including those 72 teachers and 30 others who returned the survey.

Analysis of this comparison of these 102 teachers to the national sample regarding the effect of professional development is reported in Table 18 below.

Table 18: TLC Comparisons - Effects of Professional Development

TLC Item	TLC 98 national sample N=2251	ATRL 2000 teachers N=102
Staff development/workshops have influenced their teaching practice	54.1%	76.8%
A change in their understanding of learning has influenced their teaching practice	54%	72.8%
Computer/technology opportunity and experience has influenced their teaching practice	50.7%	78.7%
The person who gives them the best ideas about teaching knows a lot about computers	21%	50%
They now participate more frequently in professional development activities	42%	59.8 %
They discuss staff development sessions afterward with other teachers	42.3%	52.4%

Table 19: TLC Comparisons – Professional Development Topics

Central Topic of Professional Development	TLC 98 National sample N=2251	ATRL 2000 teachers N=102
• New knowledge about subject matter	26.1%	35.3%
• Improving student group/peer work	17.1%	34.6%
• Computer technology/software mechanics	40.9%	76.9%
• Integrating computers into instruction	32.7%	78.6%
• How to use the Internet/other on-line work	30.3%	68.8%
• Enabling students to do multimedia work	12.1%	67.0%
• Connecting skills with real-world	15.6%	38.5%
• Connecting content with student interests	10.5%	34.6%
• Improving student critical thinking	27.6%	53.4%
• Improving student meta-cognition	12.1%	20.2%
• Improving student ability to write/review	23.2%	38.5%

As the above data show, professional development that modeled technology-integrated, constructivist practices was provided to teachers to help them shift from traditional to more constructivist approaches. Teachers needed to see how to use and integrate technology in their classrooms in ways that promote learning and that are enjoyable. The findings of this project mirror those of Sandholtz, Ringstaff, and Dwyer (1992, cited in Becker and Ravitz, 1999) who found that "the process through which teachers learn...the principles of using computers results in changed beliefs about how to improve students' understanding, competence and performance." We found that it was helpful to model this approach to learning for teachers before they could be expected to teach this way with students.

Role of Technology

Technology use. ATRL staff field notes and informal observations indicated that some sort of increased comfort in or familiarity with technology also helped teachers shift practices toward more constructivist approaches. Indeed such an observation is consistent with other research linking technology use and pedagogical practices. Jonassen, Carr, and Hsui-Ping (1998) attest that "computers can help teachers accomplish constructivist approaches that might be difficult, if not impossible, to accomplish otherwise." As teachers became more familiar with and proficient in technology use, they were more likely to use such technologies with students. Teachers reported being "surprised" by students' facility with technology and as such often accorded students more control and autonomy in terms of research and expression than

would be the case were the technology not available. One middle school teacher who normally gave students step-by-step instructions in creating poetry notebooks said: "When we first got computers, I stood over them watching everything they did. This year I realized that they know how to use computers better than me. I left them alone when they created their poetry notebooks. And they did a much better job."

Table 20 indicates how computer use by ATRL teachers compared to the national sample of teachers.

Table 20: TLC Comparisons —Computer Use by Teachers

TLC Item	TLC National sample N= 2251	ATRL 2000 teachers N=102
Compared to 5 years ago, teachers are		
Trying new software much more now	21.7%	42.2%
Using email– more often than 3-4 times a week	24.7%	56.9%
Using computers – more to much more – for class preparation	71.6%	90.1%
Using computers for non-work activities more to much more	69%	88%

Project teachers also reported on the TLC that they have more "advanced" skills related to their own use of computers; including use of images within word processing, creating presentations and searching web pages. They also report that they have increased their "routine" use of computers professionally, personally, and with students in the last five years. ATRL teachers did not report substantially more involvement in the last five years in "advanced" uses with students, although they did indicate that students used computers more to write a story with graphics.

It is important to note that 42.4 percent of the ATRL teachers report "none or few" students use computers at home or outside of school while 28.8 percent of the national sample report "none or few" students use computers at home or outside of school. However, the project teachers work in economically disadvantaged schools and students' families likely cannot afford to purchase a computer.

Access to technology. As noted previously, one of the largest shifts in practice was in the use of multiple tools and resources. In addition to the influence of professional development, increased access to technology appears related to this change. At the beginning of year one, almost all of the ATRL teachers at the six site schools had at least one operating computer in their classroom. In the interval between baseline and year one observations, many teachers acquired new hardware and software, thus furnishing them with more teaching resources. This was particularly true in one site school where almost all project classrooms moved from one computer to four.

Observations showed that when a teacher had only one computer in the classroom, it was harder to develop strategies that allowed all students equitable access to the computer. With only one computer in a classroom, the computer was often used for teacher tasks or as a reward for students who finished their other work. Teachers who wanted to allow time during class for student use of the computers tried different organizational strategies. If a teacher had several (four to six) computers in the classroom, it appeared to be easier to organize the classroom for learning. With more computers it took less time for a class to finish a project or activity in a timely way. Teachers in the middle schools who had only 45-minute class periods complained that it took too long for students to complete projects when they only had access to one or two computers.

Over the summer and by the beginning of the second year of the project, some teachers were resourceful and found additional computers or their school gave them additional computers. In one case, an ATRL teacher rounded up all of the computers in his school that no one was using and put them in his classroom. He then had a mini-lab of about ten computers in his classroom. A growing need at one site prompted the technology support person to assemble several working computers in an extra classroom to create an open lab where larger numbers of students could go to work on special projects. Teachers could schedule the room if they needed access to more computers for special project work.

According to TLC data in Table 21 ATRL project teachers reported substantially greater access to computers and technology in their schools than the national sample.

Table 21: TLC Comparisons—Access to Technology

TLC Item	TLC National sample N=2251	ATRL 2000 teachers N=102
Access to a computer	62.2%	81.7%
Access to a printer	77.8%	98.1%
Access to high speed internet from classroom	25.6%	71.2%
Access to e-mail	51.9%	97.1%

In general, observations showed that successful technology integration and high technology use took place in those classrooms where there were four to six computers available for student use. However, one teacher found that six computers were too many to manage. She explained that it totally "disrupted" her classroom organization with students working on too many activities. She also found it difficult to handle technology issues while trying to carry out instruction. In her case, technology was forcing her to change her teaching practice in a way that was unexpected and undesirable. However, the teacher with ten computers had previously been a computer teacher in a lab setting. He could successfully manage several computers and enjoyed having students working on multiple activities.

If teachers are expected to use technology successfully in their classrooms, they need to have access to the proper technology tools. This includes working computers, compatible software, access to the Internet and access to printers. Once the computers are installed, the issue becomes one of maintenance and support as discussed below. On the other hand, the presence of four to six computers in a classroom is not a guarantee that technology use or constructivist practices will take place.

Technical Support. The success of teachers' use of technology to support a constructivist learning environment also appeared to be influenced by the network configurations set by the district or school's technology policy. Unlike some innovations that are primarily the responsibility of the individual teacher, computers are connected and controlled through an institutional system and restrictions on individual use may greatly determine how a teacher may use them. Educational institutions pose unique problems for network administrators in that problems of user protection (ensuring that students are not finding inappropriate Internet sites) and user sabotage (ensuring that curious or malicious students do not reconfigure the entire network) dictate restrictions that may not be an issue in a business setting. While network security was the paramount concern of the technology director or coordinator, classrooms computers needed enough flexibility to allow students and teachers opportunities to explore, discover, make mistakes, and correct them.

Teachers reported that they needed to be assured that their computers were functioning properly and that there was onsite support to help with hardware and software problems, if they were expected to include computer use by students as a standard part of their lessons. Even if a school had sufficient and functioning technology, and teachers were eager to design learning experiences for their students, these technical issues inhibited efforts to use computer technology. When the technical aspects of the computer could not be essentially taken for granted, teachers reported their hesitance to develop lessons that integrated the computer. If student and teacher access to information, software, and computer peripherals were restricted, it was difficult for teachers to adopt new technology and new practices. Each of the site schools received technical support in different ways, as this was a condition for site selection from the beginning of the project.

Observations and site reports indicated that, in some cases, personnel in charge of the computers and the network *limited* the types of technology use in the classroom. In two site schools, strict limitations were placed on classroom computer use and teachers reported the inability to develop and use some technology-supported practices they might have used if those restrictions were not in place. In these schools, teachers could not alter the desktop of their classroom computers or add software. These tasks had to be completed by the school technology director who was often busy taking care of other problems and could not attend to installation of new software or removing and changing passwords to allow teachers to upload information to the network server.

Table 22: TLC Comparisons – Technical Support and Assistance

TLC Item	TLC National sample N=2251	ATRL 2000 teachers N=102
Technical assistance teachers received at their school perceived as excellent	10%	27%
Availability of tech support – frequently to always	48.5%	67%

Only 27 percent of ATRL teachers reported that the technical assistance they received at their school was excellent. This was not surprising in light of the negative feelings teachers at some of the sites held about the network administrator at their school. However, ATRL teachers' perception of the availability of technical support was higher than the national sample. ATRL teachers rated instructional support more highly, but the differences were not large.

To alleviate some of the technical support issues, ATRL project staff worked with the technology director in one site to create a district team of teachers who could be trained to deal with some minor issues. This strategy was an attempt to provide more time for the technology coordinator to give support to other less knowledgeable teachers. Unfortunately, the technology coordinator did not relax limitations on this group of teachers. He feared compromising the district network and expressed concerns about software piracy and what students' and teachers' use of technology in the classroom

In other schools where strict limitations were not in place, teachers were able to implement technology more freely. In one site there was no network administrator to set standards regarding the use of software by teachers. While some teachers thought it would be an advantage to have such a support person, they also reported their concerns about the limitations that it could bring. In the meantime, these teachers were allowed a great deal of freedom and had permission to install any software that they chose onto their machines.

At another site, the technology coordinator was a full-time campus based staff member. At this site, there was the highest level of technology support and, as one might expect, the least number of issues around broken equipment. Teachers created projects they could load to the school's server and share with other teachers. This appeared to encourage cross-grade level projects and collaboration.

Support

Administrative support. Analysis of field notes, interviews, and observations of project teachers' classrooms indicated that where the district and administration supported the creation of technology-rich, student-centered learning environments, such changes were

more likely to occur. At those site schools where the campus administration set an expectation that learner-centered environments would be created and that students would use the computers in the classroom, even reluctant teachers reported that they felt obligated to make changes. If the administrator was supportive of the teacher making changes at his/her own rate and style, teachers reported feeling less threatened with the process. The transition seemed easier if teachers took small steps and made changes unit by unit, adding hands-on and collaborative activities, additional resources and the computer. This process gradually reduced dependence on the textbook as a sole resource.

In four of the six site schools, administrative support remained high for technology integration and use of constructivist practices throughout the project. Administrators overtly expressed support for constructivist approaches at these sites. For example, the principal at one site stipulated that all teachers hired must ascribe to technology-integrated, constructivist approaches. Another principal frequently visited classrooms and effusively praised both students and teachers for their integration of technology and more active classroom environments. A third principal actively promoted technology skill building among his staff and was considered a pedagogical leader in the state, receiving an award from the state technology association as technology administrator of the year. Administrators at two other sites arranged for similar staff development to be conducted by project teachers for non-project teachers in the second school year of the project, hoping to expand the use of these practices to all teachers on the campus. In all of these sites, a shift toward more constructivist approaches was observed.

In one site, however, such district and administrative support was lacking, and teachers in this site showed little willingness to change their practice. Participation in professional development by these teachers was inconsistent during the second year of the project with approximately ten teachers continuing to attend professional development sessions. The lack of administrative support may have, in part, been the result of having only one or a few teachers on their campus participating in the project. Thus the project was not a priority for the campus in general. Indeed, apart from an increased use in technology, many teachers at this site appeared to have shifted toward a less constructivist approach. When the campus administration at the schools in the cluster did not set expectations for learner-centered classrooms and/or believed that drill and practice was the best way to improve test scores, teachers had little incentive to change.

Peer support. Support for teachers as they changed their practice also seemed to play an important part in the process of creating constructivist learning environments. This support came from colleagues or others such as an expert or leader.

Expert or leader. If a teacher had a mentor who provided support, then the process of creating a CLE was reportedly easier. This mentor could either be a teacher-colleague or a specialist in curriculum or technology. The mentor served as a model teacher, who came into the classroom and helped with the technology and with creating a learner-centered environment. With this intensive help on site, teachers appeared better able to make changes in their classroom environment. In addition to the regular on-site support

visits from ATRL staff, the co-developer served in this role for teachers at two sites. These co-developers were able to offer instructional ideas, classroom management strategies, and demonstrate or trouble shoot simple software problems.

Colleagues. Collaboration among teachers within instructional groups or among ATRL participants seemed to encourage teachers interested in creating CLEs. Simply talking about ideas with others helped teachers as this teacher explains. "I feel better now and as I talk to other teachers, asking questions and sharing experiences, it makes me feel more open-minded, and willing to try new things."

TLC results from the end of the second year, showed in Table 23 how the ATRL teachers compared to the national sample on the following items regarding peer collaboration.

Table 23: TLC Comparisons – Peer Collaboration

TLC Item Compared to 3 years ago	TLC National sample N=2251	ATRL 2000 teachers N=102
Increase in working with other teachers within their school on curriculum development	43.3%	66.1%
Having other conversations & discussion with colleagues	45.5%	62.1%
Spending more time discussing computers, different views about teaching and objectives, preparing lessons and reflecting about good teaching with each other	25.3%	57.1%
Sharing student work with colleagues	43.7%	65.1%

Time. When teachers changed their role from instructor to instructional designer as they implemented CLEs in the classroom, they often reported spending additional time outside the school day to do so. These teachers reported changes in thinking about lesson planning. Instead of asking, "How will I teach this subject?" the teacher asked, "How can my students best learn this subject?" This change in thinking required additional time in planning and organizing materials.

Those teachers who could not find time to make such changes reported more difficulty in adopting constructivist practices supported by technology.

Some teachers reported frustration with colleagues for what they viewed as a lack of commitment in terms of time. In a professional development session, teachers were asked to create a rubric to assess their progress in creating CLEs supported by technology. One group of teachers described the effort involved on the part of teachers as a continuum. "Doing time," described those teachers who did not want to be in the classroom. "Marking time," described those teachers who were not willing to change. Finally, "working overtime" described those teachers who worked to create and implement a CLE.

Critical mass. Critical mass appeared closely related to collaboration and peer support. Where there were larger cohorts of teachers, more collaboration and support among project teachers was reported and observed. In addition, observations and field notes indicated that the greater the number of teachers teaching with technology within a school, the more change in teaching practice was observed. When the project began, there was a requirement that 25 teachers from each site had to agree to participate in the project. In some sites there were as many as 30 participants. In one site, participation of all teachers in the school was required and participated in professional development around technology either with the ATRL staff or with their own co-developers. When the project began in the fall of the second year, attrition reduced the number of teachers at each site. This attrition was a result of teachers moving to another district, moving to a different school within the district, pregnancy, and retirement. In all cases, new teachers were added to the cohort, maintaining the group each school at 25 participants.

Prior to the ATRL intervention, there were a few teachers in each school already using technology in their classrooms and some already using some constructivist approaches. However, with 25 participants learning to use technology to support these practices, awareness and interest throughout the rest of the school and school district increased. In most cases, technology use had a cumulative effect among project teachers within a school. The exception was the cluster site. In that situation, the cohort of participating teachers consisted of two to eight teachers in five different schools. Observations and field notes indicated that teachers there did not change their teaching practice as much as teachers in schools with a larger cohort of participants.

When the ATRL project began at the one of the site schools, only the project teachers received computers for their classrooms. However, at the beginning of the second year, all other teachers on staff received at least one computer for their classroom. They were then eager to learn from the ATRL project teachers.

External pressures. Pressure to improve student scores on district and/or state assessment tests was evident at most of the sites. While the school principals at four of the six sites reported their belief that ATRL teachers could carry on with their use of technology and more student-centered practices, some teachers felt they could not do both. Based on classroom observations it appeared that that some teachers in three of the sites who showed gains in technology use and constructivist practice during year one did not necessarily make the same amount of progress the second year.

Teachers at several sites reported the emphasis on standardized testing as a reason *not* to develop CLEs supported by technology. When teachers emphasized preparing students for standardized testing they often thought they could not accomplish adequate preparation in a technology assisted learner-centered classroom, as illustrated by this comment from one teacher:

> It's been nice to be trained in the software, but I haven't been motivated to become proficient in it because I can't use it in my classroom. Right now we're in the middle of [test] preparation and my kids aren't ready. So right now, the technology is a low priority.

This pressure to improve test scores appeared to increase the amount of time teachers dedicated to teaching the tested curriculum. Two teachers in one site reported that they "didn't have time" to employ constructivist practices anymore because of the pressure to practice for the upcoming standardized tests in the spring. This surprised project staff as these two teachers were regarded as high in constructivist practice and had high technology skill levels.

It is noteworthy that responses on the *Teaching, Learning, and Computing* Survey indicate that ATRL teachers' reports of how changes in district policy/expectations influenced their teaching practices did not differ significantly from the national sample. (62.2 percent for ATRL teachers vs. 61.2 percent for the national sample) Observations and interviews with ATRL teachers seemed to indicate otherwise. While they did not directly express frustration with their principal, many teachers expressed frustration with the school district or their state's department of education, who they perceived as making the demands on them for higher scores on standardized tests.

Summary

Findings from the data indicate that many factors appeared to have influenced teachers as they changed their practice to accommodate constructivist practices supported by technology. Professional development opportunities appeared to have made a major impact on teachers' practice. Professional development that allowed teachers to construct professional knowledge about pedagogy, content, and technology, as well as strategies for managing the changing classroom environments seems to have brought about the creation of constructivist learning environments supported by technology. Just as constructivist learning theory informs the transformation of classroom environments for students, it also informs the development of learning experiences for teachers. These experiences were situated in an authentic context for teachers—their school and classrooms. Professional development built on teachers' prior knowledge and provided opportunities for social interaction with colleagues. Professional development activities also supported investigation of problems supported by technology that were relevant to teachers. By providing these experiences and allowing time for reflection, it was possible for teachers to confront their own "theories in use."

Several other factors impacted the process of change in teachers' classrooms: access to and use of technology, proficiency in technology, administrative support and technical support, collaboration and support among teachers, presence of a critical mass, models for managing a classroom with technology and addressing control issues, and influence of teacher attitude and expectations.

Findings: Research Question Three

How does technology facilitate the development of a constructivist learning environment?

Introduction

As with all of the research questions, SEDL staff began the ATRL project with certain assumptions about how technology would support constructivist learning environments. A synthesis of the research literature (Dimock & Boethel, 2000) indicated that technology could be a natural fit with constructivist learning environments. Other discussions of technology and constructivist approaches (Adams & Burns, 1998) point to the ways in which certain computer applications lend themselves to constructivist approaches. For example, the World Wide Web decentralizes information, thereby allowing students to assume some manner of expertise without relying upon the teacher. Simulation software allows students to virtually recreate real life experiences that might otherwise be too dangerous or expensive to conduct and allows them to determine the cause and effect of their actions as they compete with a virtual opponent. Database software allows students to classify and categorize information, employing decision making authority in the process and analyzing information based on a set of pre-determined criteria. Finally, computer mediated communication, through e-mail and list servers allows students to communicate with experts and collaborate with peers beyond the four walls of the classroom. Therefore, a project assumption was that an increase in technology use could result in an increase in the use of constructivist approaches and by extension, that an increase in teachers' technology proficiency would automatically yield an increase in their use of constructivist approaches.

Findings

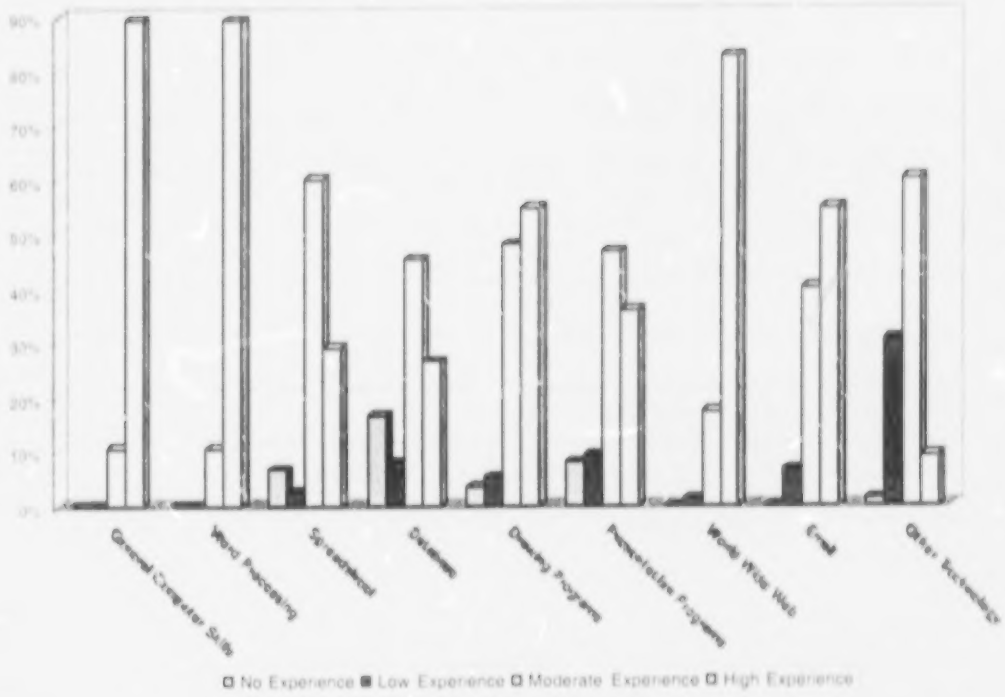
Three instruments were used to assess teachers' proficiency with and use of technology in the classroom: the computer skills self-assessment, the classroom observation protocol, and the Teaching and Learning with Computers (TLC) survey. Additionally, analysis included coding of interview transcripts, field notes, and informal observations to determine how technology might facilitate the development of a constructivist learning environment (CLE).

Proficiency with technology. The computer skills self-assessment (See Appendix 10) was administered to teachers before the start of the project, after year one and at the end of year two. Teachers were asked to assess their skills in technology from "no experience" (0) "low experience" (1) "moderate experience"(2), or "highly experienced" (3). Since this was a self-assessment, it may be argued that this is more a measure of confidence and comfort level with technology than actual proficiency.[11]

Figure 4 tracks teachers' self-reported proficiency over two years. In those technologies that were employed during the two years of ATRL professional development—word processing, the Internet, hypertext programs, electronic presentation software, drawing programs, spreadsheets (in two schools) and databases (in one school)—teachers reported the greatest gains in proficiency. For example, by project end, nearly 90 percent of teachers reported being "highly experienced" with computers in general and with word processing software, and over 80 percent reported being highly experienced with the World Wide Web. Ninety percent reported "moderate" or "high" experience with drawing programs and presentation programs. Figure 6 (on page 66) demonstrates that these were also the applications most in use by students.

[11] For example, several teachers assessed themselves as having "moderate" experience with a certain software application, whereas observers would have rated them highly experienced.

Figure 4: Computer Skills Self Assessment by Application

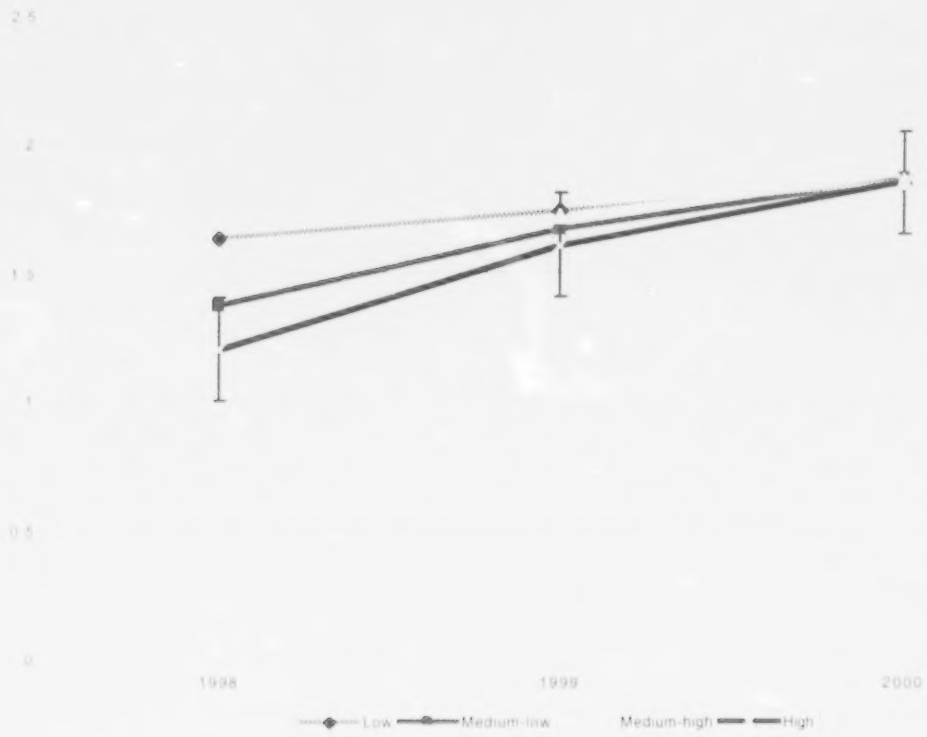


It appears that there is a link between professional development and teacher comfort or confidence as measured by the computer skills self-assessment. Cross tabulated results of the computer skills self-assessment and the classroom observation protocol, however, did not indicate any statistically significant relationships between teacher proficiency with technology and an increase in constructivist practices in the classroom.

This lack of statistical significance is illustrated by Figure 5 which tracks the increase in computer skills among the four clusters of teachers—low, medium-low, medium-high, and high constructivism. A convergence of self-perception of technology skills across the clusters illustrates this lack of relationship. In the baseline year, those teachers in the high constructivism category had the lowest self-perception of technology proficiency (a mean of 1.20). Conversely, those teachers in the low constructivist category reported the highest technology skills (a mean of 1.63), though the difference between the highest and lowest technology skills was marginal. By year two, the technology skills of all four clusters appeared to converge and reach parity (from 1.84 to 1.86). This increase in self-perception of technology skill was marginal, yet, the increase in constructivist approaches over this same period was substantive as discussed previously. The modest gain in self-perception of technology skills across all clusters and the slightly higher technology skills of teachers who used fewer constructivist approaches appears to

indicate no relationship between technology proficiency and the creation of constructivist learning environments, unless it is a weak negative one.

Figure 5: Change in Teacher Computer Skills over Time



Impact of increased classroom use of technology. There did appear to be a link between teachers' comfort or confidence with technology and their use of technology with students. Technology, when used with students, seemed to play a role in the creation of constructivist learning environments. Analysis of computer skills self-assessment data, the TLC survey, field notes, teacher interviews, and informal observations indicated that when technology was used, it helped teachers shift practices toward more constructivist approaches. Indeed, such an observation is consistent with other research linking technology use and pedagogical practices (For example, Jonassen, Carr, and Hsui-Ping, 1998).

The computer skills self-assessment and TLC survey indicated that participating teachers increased their use of technology with students. In baseline reporting, only 50 percent of teachers reported using the computer with students on a regular basis. By the end of year two, 75 percent reported regular computer use with students. The majority of non-users were teaching in one site school where technology support was

unavailable. Hence, these teachers may have been unable to use their computers because many were not functioning.

Sixty percent of project teachers reported that computers played a substantial or major role in changing their teaching on the TLC survey, as compared with only twenty-eight percent of the national sample.

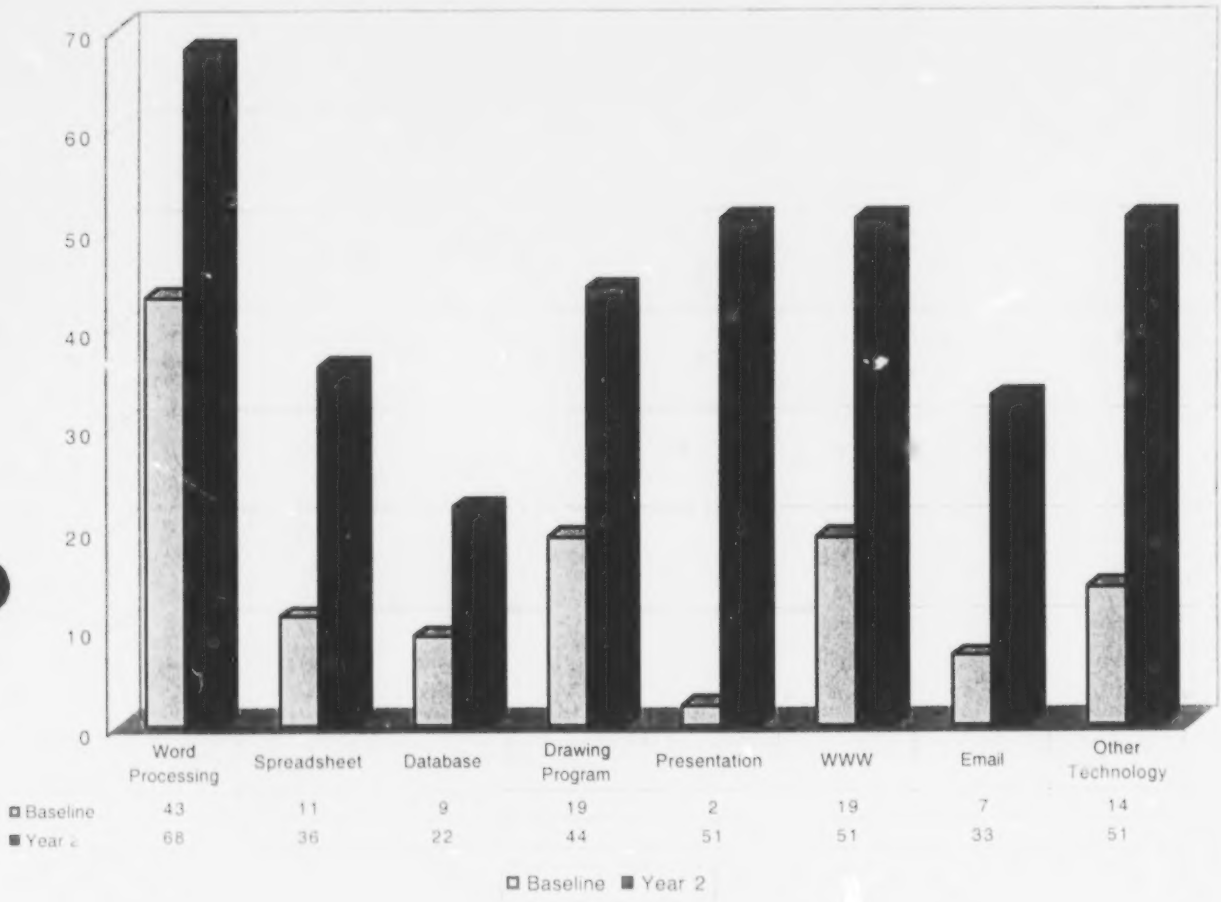
Table 24: Instructional Uses of Technology: ATRL Teachers vs. National Random Sample

Instructional Use of Technology: Objective Selected	TLC 1998 N=2251	ATRL 2000 N=102
Expression in writing	66.6%	81.1%
Communicate electronically	24.6%	40.0%
Find out about ideas and info	71.4%	84.2%
Present info to audience	41.2%	72.6%
Improve computer skills	69.5%	84.2%
Learn to work collaboratively	57.9%	83.2%
Learn to work independently	72.7%	84.2%

Uses of technology. Table 24 compares the ways in which ATRL teachers reported using computers with students with the uses reported by the national sample. As the data illustrate, project teachers' use was higher in all categories, particularly those rated as constructivist by the TLC's authors. These include use of computers for written expression, presentation of information to an audience, and learning to work collaboratively and independently.

Increased use of software. In Figure 6, disaggregated data about what types of applications commonly used by project teachers is displayed. Before the start of the ATRL project, the most commonly used software applications were word processing (with 43 percent of teachers reporting use in their classes) and to a much lesser extent, the World Wide Web and presentation software (19 percent of teachers reporting regular use). By year two, software use had increased dramatically in some instances. Sixty-eight percent of teachers reported regular student use of word processing software and over 50 percent reported regular use of presentation software (up from 2 percent in 1998), the World Wide Web and other technologies, such as scanners and digital cameras.

Figure 6: Computer Use in Classrooms: Baseline vs. Year Two



Increased student motivation. As teachers became more familiar with and comfortable in technology use, they were more likely to use such technologies with students. Teachers reported being "surprised" by students' facility with technology and as such often accorded students more control and autonomy in terms of research and expression than would be the case were the technology not available.

For example, one middle school special education teacher remarked that her students' writing was much better when they used a word processor than when they wrote with pen and paper. "They really take the time...they want it to be perfect...and they're so proud of it...It's like, 'I did that.'"

During one professional development session, a teacher brought examples of students' work from a cereal project in which students used the ingredients and unit prices of

their favorite cereals to study linear equations. The teacher read a letter from one of her students, known to other teachers in attendance. This student was not considered an "A" student. The student's letter thanked the teacher for a project that was "real world" and that allowed the students to be "creative" and work together. The student mentioned that this non-traditional way of using math plus the use of the computer (Internet, e-mail, spreadsheet, word processing and electronic presentation software) truly "prepared (us) for college and the working world." The student remarked that this project-based method was more effective in terms of her own learning than "the 12, 000 year old method" of textbook and questions.

For another middle school special education teacher, a gift of six discarded but functional Apple IIEs finally allowed her students the opportunity to use word processing and spreadsheet software. "Their work is excellent," she remarked incredulously." They're coming in during recess and lunch begging me to let them do their work!"

Finally, another teacher commented:

> This semester we wrote the safety reports... the kids are learning things in (another) class; they are coming to mine and they're getting on the computer and they're writing. They go back to the other class and they're coming back and changing and adding things on that report, and that report just gets better and better. They start to see the mistakes they generally make, grammar, spelling, logic, just trying to explain something to another person on paper, and we're just constantly editing and giving it back, and they'll give another copy and will edit and give it back. It just becomes more and more refined and polished. I personally don't understand all the literature I keep reading all over the United States where they keep saying computers don't increase learning because the quality of the papers that I'm getting from my students is just astronomically better than what I got before I had the computer. Kids would not rewrite things before, but now they're willing to correct their mistakes.

Increased expectations of students. Project teachers reported that not only were they surprised by the quality of students' work—the professionalism of their word processed report, the eye catching quality of an electronic presentation—but that they were often surprised by students' academic ability. Interviews with project teachers mentioned that the quality of students' work improved greatly when they were allowed to use technology and that students were often more willing to tackle harder tasks:

> They're learning but they don't know they're learning so they're willing to do anything.

> It's funny but if I ask them to write a three-page essay with pen and paper, they don't want to do it. But if I ask them to write a ten-page paper on the computer they jump to it.

> (Before I actually started using Accelerated Reader), the kids wouldn't read. But now that they can use Accelerated Reader, their reading scores have jumped by several grade levels.

It is important to remember that the majority of these students were low-income and/or ethnically diverse students, from whom some teachers[12] expected little in the way of academic excellence. However, because of these academic improvements, teachers appeared more confident in allowing students greater autonomy and this in turn, seemed to result in improved student performance.

Means and Olson (1993) as cited in Knapp & Glenn (1996) found that technology often stimulates teachers to present more complex tasks and material, that it allows them to become coaches and facilitators, and that it can add significance and value to a task for students. This allows teachers to "open up" more—creating curriculum that is richer and more complex, engaging students in experiences that are more nuanced, allowing students to assume more responsibility, such as rubric design for the purpose of assessment, for example. Other research (Cotton, 1991) mirrors the teachers' sense that the use of word processors results in better writing outcomes than use of pencil and paper and that lower-achieving students, younger students, and economically disadvantaged students tend to benefit more from technology assisted learning.

Decreased control. As noted previously, maintaining control in the classroom seemed to be one of the biggest impediments to changing classroom practice. Many teachers, fearing chaos, appeared unwilling to give up control in terms of pedagogical practices. However, technology seemed to be the first area where teachers willingly ceded control to students. Many teachers acknowledged their students' technological proficiency and expertise and deferred authority over technology products to students. This mirrors the findings of other researchers (Sandholtz, Ringstaff, and Dwyer, 1997).

Teachers reported that when they granted students autonomy in terms of computer product creation (e.g., web pages, word-processed reports and electronic presentations) that the students functioned quite well with little or no teacher intervention. It appears that once this initial control was lessened teachers became more willing to cede control in other non-technological matters as well. For example, teachers began allowing students to determine the appearance and content of a final product or granting students more authority in the type of assessment to be conducted.

Alignment with content. As teachers adopted more technology-integrated, constructivist approaches, they began to see a need for alignment or integration of such approaches with their content area. This happened particularly in terms of technology. Technologies such as the Internet, word processing software, presentation software, and content-specific CD ROMs assumed a more prominent role in terms of content and content creation. Informal observations of project teachers noted that students frequently used the Internet and on-line encyclopedias for research. Indeed in many classes, the Internet and *Encarta* supplanted the textbook as the primary information

[12] Based on informal interviews with teachers.

source, while in other classes the Internet and *Encarta* rivaled the teacher as the primary information source (with the teacher's blessings). This example addresses the previously raised control issues and shows greater flexibility among ATRL teachers in terms of content creation.

Learning with new tools. Technology also became a salient tool in the classroom. Many project teachers had a TV/VCR connection to a computer in their classroom and used this system to display class assignments. Additionally, student use of technology became an important feature in most project teachers' classrooms. Students routinely word processed reports and stories, used concept mapping software for story telling, did research on the Internet, used spreadsheets for quantitative analysis, and displayed their findings via electronic presentation software.

Technology changed the ways in which students accomplish their tasks. Because no teacher, with the exception of the computer science teachers, enjoyed a 1:1 student-computer ratio, students were grouped around computers in order to do their work. This resulted in greater student collaboration and communication. The resulting shift in the way work was accomplished led many teachers to restructure curricula to allow for greater technology use and student activity.

Once this incorporation occurred, technology seemed to serve as a catalyst for a shift toward more constructivist approaches in the classroom. Teachers' enthusiasm about technology served as the impetus for more reluctant or skeptical colleagues to attempt use in the classroom. Field notes indicated that successful use by colleagues—especially where increased student performance was noted—was a major incentive to spur other teachers into using technology with students.

The nature of technology. Thus, the use of technology with students, appeared a catalyst for change toward more constructivist approaches. Because classrooms lacked a perfect ratio between students and computers, teachers grouped students in order to take advantage of technology. To allow for such groupings, both the physical configuration of the classroom and the organization of the class became less centralized. Students worked together and relied on one another—as opposed to the teacher—for guidance and creative input. Thus the teacher became more of a facilitator. When the teacher witnessed students' creativity, and in many cases, proficiency with technology, he or she appeared more inclined to give students even more autonomy around their work. There was evidence, from formal and informal interviews that this approach transferred to non-computer activities as well. Ironically, the scarcity of resources resulted in more creative and fuller uses of those resources.

By its very nature, technology appeared to further influence the creation of constructivist learning environments. For example, computers were utilized to allow learners to build upon their prior knowledge of a particular domain. Students chose among a variety of software depending upon the task they were faced with completing, e.g., analysis of a particular problem, classification of varying pieces of information, creative self-expression or reporting a story or event. Computers were utilized to foster such active experiences as gathering data and resources or for reflection, such as on-line conversations or electronic journal writing. Students used e-mail, chat rooms and list

servers to communicate beyond the boundaries of their campus. They also communicated together around the computer, as a group, as they prepare an electronic product. Finally, students worked through computer activities at their own pace.

Table 25 examines teachers' attitudes and practices using technology as reported on the TLC and the manner in which technology facilitated change in their teaching practice. A number of items are worth particular mention. For instance, 90 percent of ATRL teachers stated that they used computers in the class in which they felt most successful. In terms of constructivist practices, nearly 31 percent of ATRL teachers reported that they allowed themselves to be taught by students; 53 percent reported that students taught one another in their classes; nearly three-quarters said they allowed students to review and revise their work more now as opposed to three years ago; and 62 percent reported that, compared to three years ago, students explored topics on their own more now. The teachers' responses align with research about the link between student-centered practices and technology. Valdez *et al* (2000, iii) report that technology:

> Offers opportunities for learner control, increased motivation, connections to the real world, and data-driven assessments tied to content standards that, when implemented systematically, enhance student achievement as measured in a variety of ways.

Table 25: Computers' Effect on Instruction and Teacher Practices: ATRL Teachers vs. National Random Sample

TLC Item	TLC 1998 N=2251	ATRL 2000 N=102
I use computers in the class where I feel most successful	60.1%	90.2%
Compared to 3 years ago, I have allowed myself to be taught by students.	Much more now 13.7%	Much More now 30.8%
How much of a role have computers played in making changes in teaching?	Substantial-Major Role 27.7%	Substantial-Major Role 60.2%
Compared to 3 years ago, students teach or help other students.	More now 40.8%	More now 53.4%
Compared to 3 years ago, students review and revise their own work	More-Much more now 58.6%	More-Much more now 74.8%
Compared to 3 years ago, students explore a topic on their own	More-Much more now 54.4%	More-Much more now 62.2%
Compared to 3 years ago, I work with other teachers on curriculum planning	More-Much more now 43.3%	More-Much more now 66.1%
Compared to 3 years ago, I talk with other teachers about teaching strategies	More-Much more now 53.9%	More-Much more now 77.7%
How much of a role have computers played in changes in your teaching practice	Substantial-Major role 25.3%	Substantial-Major role 57.1%
Computers affect the way you organize space in your classroom	Big change 12.7%	Big change 30.1%
Computers affect the way you break up your class period into activities	Moderate-Large change 24.2%	Moderate-Large change 60.2%
Computers affect your beliefs about curriculum priorities	Moderate-Large change 27.5%	Moderate-Large change 44.4%
Computers affect your goals in teaching	Moderate-Large change 32.9%	Moderate-Large change 54.3%

Becoming a Learner

Another ingredient in the role of technology in facilitating change toward a more constructivist learning environment appeared to be in the area of the teachers' own learning. This report has mentioned teachers' co-learning with students, but staff field notes indicate that technology may have provided a "safe context" (Valdez et al, 1999, 14) for teachers to become learners again. In "learning how to learn" as it were, teachers become more cognizant of the most optimal approaches for their own learning. In both formal and informal interviews with project teachers, they indicated the types of approaches teachers believe work in terms of teaching about technology and integration.

> Last year, we would all sit in a lab and follow [the trainer]. I immediately got lost but he never said we could work together, so I didn't want to bother anyone. I just turned into one of the kids; I tuned out and played *Solitaire* [on the PC] for the rest of the day.

This teacher reported that she stopped going to additional training sessions.

> We'd have these classes by the district. Instead of bringing in a teacher who could share activities she had done with the computer and let us work together, they brought in what I call "big wigs" who just stood up there and talked at us.

> Last year while I was at [a special summer technology integration program], [the trainer] couldn't figure out how to do something on the computer. She made us sit there for about 15 minutes while she tried to figure it out. She never asked us if we knew or let us try to figure it out. I got so fed up with waiting that I said, "Here, let me show you how to do it." She was annoyed with me.

In contrast to these experiences, other teachers reported the following about learning how to learn:

> What was so wonderful about [the ATRL] sessions was that it was so hands on. We were just like the kids. They gave us a problem and we had to figure it out. We (the teachers) had to work together as a group to figure it out. We learned how to use the technology together and we had a blast.

> The [ATRL facilitators] put us in the role of students. And we experienced the same frustrations as the kids, so we learned what to do and not do with our students.

> We could work together on the computer. We didn't have to work alone. And we had time to figure things out. Sometimes I don't think we give kids enough time to figure things out. We expect them to get it right away

> when we don't get it right away...I liked the rule about not touching the mouse or keyboard. It helped me to learn not to take over with my students.

Comments such as these indicate that teachers recognized that certain practices (e.g., lecturing, working in isolation, the one size fits all approach of everyone doing the same thing at the same time) were not optimal for learning, while other practices (e.g., working together on an authentic task or working together collaboratively) were more closely associated with their learning. They became aware of what they liked and didn't like and approaches that were useful and others that were not as meaningful. In addition to this cognitive element, there appeared to be an affective component at play: teachers realized that technology makes learning more fun and that their students, like they themselves, are more likely to engage in activities when they enjoy them.

This learning process around technology and the teachers' cognizance of their role as learners may have propelled teachers to create more learner-centered approaches. The process of learning how to use and integrate technology created new dynamics of learning for teachers and impacted the manner in which they relate to content, their colleagues and their students.

Links to Constructivist Principles

In terms of their own technology skills building, teachers utilized constructivist approaches in terms of their own learning. Thus, the technology itself may have served as a vehicle for attaining the types of constructivist approaches modeled in professional development sessions. Some links between learning technology and the project's six working constructivist principles were noted as follows:

Prior knowledge. In general, teachers, especially those teaching older students, reported that they recognized that their students had a greater degree of comfort and proficiency with technology than they. Hence, many teachers acknowledged students as experts and asked students for assistance in using technology. Further, in staff development sessions teachers were observed tracking their own knowledge about a particular computer-related task or skill, "Okay, how did I do this before?", "What do we remember from the last time we did this?" and other such comments.

Social interaction. The prevalence of the limited computer classroom, in which teachers had one to four computers, meant that teachers put students in groups in order to use the technology. Such grouping resulted in greater communication and collaboration among students. The process of learning to use technology also appeared to have enhanced communication and collaboration across faculty. Teachers asked one another for help and taught each other and work together on projects involving technology ("Two heads are better than one"). During the first half-hour of each SEDL professional development session, where teachers shared activities they'd done with students, teachers commonly interjected, "That sounds great. Can my class do that with you next year?", "We do something similar. Let's work together on that." or "Can you show me how to do that?"

Internal Mediation. Control was an important issue for teachers and for many teachers that meant there was only one way of doing things and that the teacher knew best. However, as the teachers worked together on a particular activity on the computer, they came to realize—from their colleagues and via exploration of the software— that there were many examples of, for instance, good slide shows, multimedia presentations or word processed documents. Indeed, they learned that there were also many ways to create such products. Further, although working together in a group, the voice of the individual appeared to be validated and respected. It appeared that teachers' transferred this learning to their classes. During year two observations, in particular, teachers were more frequently observed allowing students greater autonomy in choosing how to present a final product or greater choice in terms of how they learned. This greater autonomy was coupled with a noticeable reduction in micro-management. Field notes record more instances of teachers using such phrases as "That's up to you" or "It's your choice" when discussing how to carry out a certain activity.

Increased Communication

Increased communication among ATRL participating teachers appeared to be a corollary to teachers' increased awareness of themselves as learners. As teachers learned new technology skills, they were eager to share their knowledge with colleagues and strategize ways to weave this technology knowledge into the curriculum. Communication among teachers appeared to positively impact shifts in teachers' pedagogical practices as marked changes in pedagogical practices were noted among teachers who communicated more with peers. This communication could be formal (as in the vertical and horizontal teacher teams of one site school) or informal (as in the case of very close faculty at another site school). A number of teachers reported that this closer communication usually revolved around technology: i.e., faculty members helping one another use or problem-solve with a piece of software for a particular curricular purpose. Though technology may have been the catalyst for this increased communication, communication expanded to include the sharing of ideas within and across subject areas and called for interdisciplinary collaboration and team teaching.

Where little communication among faculty existed, change was less evident and in the case of some teachers, non-existent. This is most evident in the cluster site where, because of the small number of faculty members participating from each school (in one instance, three faculty members) and because of the geographic distance between the five participating schools, communication was minimal. Teachers were not able to profit from the daily cross-fertilization of ideas that occurred at the other five sites. This lack of communication was exacerbated by the lack of reliability of some of these schools' Internet connections. This dearth of communication—both actual and electronic—may in part explain the slow pace of pedagogical change at this particular site school.

Increased communication also "trickled down" from teachers to students, as teachers reported and field notes recorded, greater teacher-student communication and student-student communication. Regarding the former, many though not all, teachers appeared

to be willing to view the student as the technology expert and frequently solicited student help around technology issues. A number of teachers reported that they regularly consulted students for technology advice and one teacher had her own student technology tutor. Further, as evidenced by the higher frequency of cooperative and collaborative groupings, many teachers also attempted to allow greater student-to-student communication within the classroom. This claim appears to be buttressed by data in Table 25 (on page 71), in which 66 percent of project teachers reported that they were more /much more likely to talk with other teachers about curriculum planning and nearly 78 percent reported discussing teaching strategies with colleagues than they were three years ago.

Increased Collaboration

Increased teacher-to-teacher communication often resulted in more attempts at teacher collaboration. Specifically, in year one of the ATRL project, a number of teachers undertook cross-curricular and multi-grade level activities that incorporated technology. This appeared to expand in year two. At one school, multi-grade language arts, reading and social studies classrooms created a Civil War Readers' Theater, while 7th and 8th grade language arts, science, math, and art teachers participated in an interdisciplinary unit, *Sadakko and the 1000 Paper Cranes*. This unit involved a science activity using pennies to calculate the half life of uranium; email correspondence with children who had leukemia (in language arts class); symmetrical drawings and origami (an art activity) and using graphing calculators in math to determine how many days Sadakko would need to create 1000 origami paper cranes. In two schools, 3rd and 7th graders and 1st and 5th graders, respectively, formed yearlong "reading buddies" where they took turns once a week reading to one another. The 3rd and 7th graders also worked together on a "US Road Trip" activity in which they chose a state to visit, researched it, and created a slide show highlighting the attractions of that state.

Since 48 percent of the ATRL project had never used computers in their classes two years ago, the prospect of learning technology was daunting. Many teachers reported to that technology made teachers collaborate more. "Because we didn't know how to use it, we were all in the same boat, so we looked out for each other and helped each other a lot." Another reported that the teachers on her faculty were "always really close, but having to learn the technology has made us even closer. (Teachers) are always coming by and saying, 'Do you need help with anything?'" Another teacher reported that her colleagues in the ATRL project have been "very supportive…a couple of people were not supportive in the beginning and suddenly they said, 'I see the value in that.' They've been turned on…we have come a long way." Means and Olson (1994) also found that as teachers begin to learn about technology themselves they are eager to share their new found expertise with students and colleagues (p.18).

What impact has this collaboration borne of technology expertise created? "A community of learners," reports one site facilitator. "We had to learn how to learn again and we did it together and relied on each other. We loved it. Most important, we became a community of learners, and we passed this on to our students. Now they are a community of learners too."

Summary

Teachers changed their classrooms and technology was instrumental in that change. While the presence of technology may make teachers cognizant of the need to change instructional practice, it did not result in changin ; practice *per se*. Rather, using the ATRL teacher's experience, change appeared to occur with teachers' increased confidence/comfort using technology. As they learned to use technology, they became conscious of themselves as learners and become more cognizant of best instructional practices. Typically, project teachers indicated that the constructivist approaches modeled in professional development sessions, such as: allowing teachers to work collaboratively; learning to use technology in an exploratory, just-in-time, non-threatening manner, in small bites (versus an intensive, long session); a combination of action and reflection; and self-paced activities were meaningful to the teacher's experiences. Teachers then seemed to utilize such approaches, with and without technology, with students.

Further, as teachers became more comfortable with technology, they were more likely to let students use it. Once teachers allowed students to use technology and saw that many students had a certain amount of expertise they were more likely to cede control of technology to students. Once this control was loosened, and teachers saw that students worked well with technology and that their work improved as a result, they began to loosen control in other areas, granting students' greater autonomy in their work. This process was a gradual one but resulted in the locus of activity shifting from the teacher to the student. The teacher became less a repository of knowledge and more a general manager of classroom operations. The student role, in turn, is also transformed from a spectator to the protagonist in the learning process.

Chapter 3

Discussion

The *Applying Technology to Restructuring and Learning* project began with several assumptions about developing constructivist learning environments supported by technology. These assumptions were based on our previous experiences in supporting change in general, in helping teachers learn to use technology (Dimock & Rood, 1996), and from a review of the literature (Boethel & Dimock, 1999). In some cases, original assumptions were found to be invalid. Some resulting learnings are discussed below.

- *With good planning, the use of one computer in a classroom can change students' learning and teachers' practice.*

  While teachers who had only one computer can and did change their practice, that change was minimal compared with the changes observed in classrooms with more than one computer. Even with good planning, compared to classrooms that had two to six computers, there was often minimal technology use, minimal change in student learning and minimal change in teaching practice. It was difficult for these teachers to use student-centered approaches such as collaborative groupings and problem-solving activities using technology. However, the presence of many computers did not necessarily result in a constructivist learning environment.

- *It is necessary for a teacher to first have strong personal computer skills before introducing and using computer technology with students.*

  Knowing how computer technology can be used to enhance learning and being able to plan effective learning activities were shown to be more important than having strong personal computer skills. In the six study sites, teachers who had average personal computer skills were able to integrate technology into their classrooms effectively because they recognized the importance of it as a tool for learning. These teachers learned how and when to relinquish control so that students could teach each other how to use the computer. It appears that confidence or comfort with technology is more important than expertise. Teachers who recognized the potential of technology's instructional promise, despite their own limitations with technology, demonstrated greater success in creating technology integrated classrooms.

- *Past experience with assisting teachers to learn to use technology to support CLE's indicated that teachers will choose between learning new instructional strategies or learning how to use technology.*

  For many of the project teachers, implementing technology became a catalyst for instructional change. Once these teachers made a decision to let students use technology, change appeared to flow from this decision. Professional development that engaged teachers as learners and modeled the integration of technology with

learner-centered approaches enabled many teachers to implement both technology and constructivism concurrently. While the addition of technology did complicate many of the teachers' lives, it was evident that many teachers were able to learn new ways instructional strategies while learning and using technology.

- *Based on what we know about the implications of constructivist learning theory for practice, a replicable model of a technology assisted constructivist learning environment would emerge from the project.*

  Analysis of the observation data of the classrooms conducted in the six site schools and interviews with six case study teachers indicated that there is no single model or prototype of a constructivist learning environment supported by technology. Instead, classrooms fell along a continuum described as: low, medium-low, medium-high and high constructivist practice supported by technology. There appears to be constructivist approaches that are replicable, but no single model that is replicable. Particularly as we looked across subjects being taught, we found that teachers seemed to select approaches that fit most closely with practices they had used in the past and combined them to create new instructional strategies. The variations in practice grew to create a wide range of classroom environments using technology.

- *Single- minded and motivated teachers can bring about change within their instructional group or school.*

  Prior to the SEDL intervention, there were a few teachers in each school already using technology in their classrooms. However, with 25 ATRL participants using technology, collaboration and communication among teachers and students increased greatly. Observations indicated that more change in teaching practice and technology use took place where there was a greater number of teachers teaching with technology within a school.

- *Change in teachers' practice and use of technology, once started, will progress in a positive direction.*

  We found that the change process was not a linear progression over time. While most teachers made great gains in year one, some teachers made fewer gains or even "backtracked" in their progress during year two. In some cases, teachers reverted to safe practices when faced with an external crisis.

Conclusions

Technology adds yet another skill set that teachers must master. As Sandholtz et al. (1997) point out, "The addition of technology can exacerbate or enhance the already complex challenge of teaching" (p. 183). While the addition of technology did complicate many of the teachers' lives, it was evident that many teachers were able learn both new instructional strategies while learning and using technology. Kay, the New Mexico case study teacher noted that constructivism and technology go hand in hand for her. "I have really learned about constructivism *through* the technology."

The understanding that knowledge is not a fixed set of facts or skills, but is uniquely constructed by each learner based on prior knowledge, experiences, and interests, implies that students, not the teacher, drives the learning process (Taylor, Fraser, & Fisher, in press). In this case, "students" were the project teachers. The ATRL project therefore acted on the understanding that each teacher brought a unique set of previous experiences and prior knowledge to the change process.

The case studies presented in Appendices 1-7 provide in-depth descriptions of six teachers and their process of change and how they created their own model of a constructivist learning environment supported by technology.

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Appendices

Appendix 1

Case Studies Overview

Background

The case studies presented here were conducted as part of a research and development project of the Southwest Educational Development Laboratory, the *Applying Technology to Restructuring and Learning (ATRL)* project. This project was designed to provide descriptive models of constructivist learning environments supported by appropriate technology.

The project, which focused particularly on schools with high populations of traditionally under served students, involved an intervention study with a two-tiered design. Tier One was a collective case study of approximately 150 classrooms whose teachers participated in professional development and support conducted by ATRL project staff. Tier Two was detailed case studies of six individual teachers whose experiences reflect a variety of responses to the goal of employing technology to support the development of a constructivist learning environment.

The study as a whole was grounded in an interpretivist paradigm with the goal of "understanding the complex world of lived experiences from the point of view of those who live it" (Schwandt, 1994, p. 118). The study employed a qualitative strategy to answer the research questions, although both quantitative and qualitative data were collected and analyzed.

Three research questions guided this study:

1. What do constructivist learning environments look like in practice, particularly in classrooms with high populations of culturally and linguistically diverse students?
2. How can teachers be assisted in developing constructivist learning environments supported by technology?
3. How does technology facilitate the development of a constructivist learning environment?

Six school sites were selected to participate in this study, one each in the states of Arkansas, Louisiana, New Mexico, and Oklahoma, and two within the state of Texas, one of them rural and one urban. ATRL staff used the following criteria for selecting these sites:

- High concentrations of economically disadvantaged populations based on the percentage of students qualifying for free and reduced lunch.
- High concentrations of culturally and linguistically diverse students.
- Rural and urban settings in the U.S./Mexico border region, Mississippi Delta region, and the Indian nations.

- A commitment from administrators and classroom teachers to support the creation of technology-rich learning environments that employ instructional approaches consistent with constructivist learning theory.

ATRL staff collected data for each of the 150 teachers in this study, including demographic data, initial classroom observations of all participating teachers (using a highly structured observation protocol), sample lesson plans, teacher personal profiles, teacher self-assessments of computer skills, informal interviews, e-mail correspondence, and field notes.

The purpose of these six case studies presented here is to provides rich descriptions to help answer Research Question 1: "What do constructivist learning environments look like in practice?" Through their personal journeys, each case study teacher also sheds light on the remaining two research questions.

Selection of the six case study teachers was made through preliminary analyses of all the data collected during the first year of the intervention. From the analyses, ATRL staff identified six classrooms that emerged as examples of constructivist learning environments supported by technology. Case study teachers then participated in three one-hour interview sessions at the end of the second year of the study,

Case study teachers were selected to represent a range in movement for the use of technology to support teaching and learning along a continuum from "low technology-low constructivism" to "high technology-high constructivism." Case study teachers were also selected to represent a variety of teaching experience, a variety of grade levels serving student populations from diverse cultures, and a variety in the amount of technology available in their classrooms.

Each of these six case studies was set in a different cultural setting and in a different geographical location in the south central U.S. The teachers tell their own story. They talk about their background, understanding of their students, teaching philosophy, teaching strategies and the way that they have learned to use technology and constructivist practices. Many have lived in their community for years and know their students and families quite well. No attempt to compare the cases has been made. The stories stand alone and provide a rich description of each teacher in his or her own unique setting.

The six case studies

Arkansas. The Arkansas site was located in a small community at the foothills of the Ozark Mountains, in the northeast corner of the state and adjacent to a major river. Agriculture, logging, and other small industries supported the local economy. This community's available labor force can be described as "blue-collar". All of the district's schools were on a single campus. Ninety-seven percent of the district's students were white, and 50 percent of students qualified for free or reduced lunch.

The case study teacher in this site, Roberta, was a fourth grade teacher with more than 20 years of teaching experience. The type of technology-assisted constructivist learning environment that Roberta exemplified may be characterized as a "Project-Based" learning model.

Louisiana. The Louisiana site was situated in a middle school in a semi-rural community in the Acadiana region of the state. Nearly half (65 percent) of the student population was African American with strong roots in the Creole culture; most of the rest of the students were white, with strong roots in the region's Cajun culture. The school was classified by the state as "at risk;" 75 percent of students qualified for free or reduced lunch.

Jeanette was the case study teacher at the Louisiana site and taught 6th, 7th, and 8th grade Language Arts. She was beginning her fourth year of teaching at the project's inception. The type of technology-assisted constructivist learning environment that Jeanette exemplified may be characterized as a "Collaborative-Learners" model.

New Mexico. The New Mexico site was situated in a rural agricultural community located in a river valley in the south central portion of the state, near the Rio Grande River. This area is rich in Mexican-American culture and history with its close ties to Mexico. Migrant workers, following the harvests, move in and out of the area, depending on the season. However, many families have lived in the area for several generations, some establishing successful businesses. Spanish remains the dominant spoken language. The student population, like that of the district, was more than 90 percent Hispanic; nearly 80 percent of students qualified for free or reduced lunch.

Kay was the case study teacher at the New Mexico site and had been teaching for 14 years in this same middle school. At the beginning of the project she taught low-performing students in a language arts reading lab. At the beginning of the second year, she was assigned to teach Language Arts in a general 7th grade classroom. The type of technology-assisted constructivist learning environment that Kay exemplified may be characterized as a "Student-Focused" model.

Oklahoma. The Oklahoma site was situated in a depressed rural county in eastern Oklahoma near the foothills of the Ozark Mountains. The main industries of the area are a regional state college and numerous plant nurseries, as well as tourism related to two large recreational lakes. Almost all the schools in the county served a predominantly American Indian population who sought to preserve their heritage, in spite of the low proportion (three percent) that speak Cherokee as their first language.

The schools enrolled a total of 1,860 students, of whom 62 percent were American Indian, primarily Cherokee. Almost 80 percent of students in the five schools qualified for free or reduced lunch.

Clay was the case study teacher from the Oklahoma site and taught several different subject areas in the 6th, 7th, and 8th grades, with responsibility for as many as six class preparations each day. Clay also coached football and drove a school bus. The type of technology-assisted constructivist learning environment that Clay exemplified may be characterized as a "Wishful-Thinker" model.

Texas rural. The rural Texas site was situated in a small Mexican American community west of El Paso, Texas, near the banks of the Rio Grande River. The Mexican American Legal Defense Fund has identified this border town as containing one of the poorest census tracts in Texas. This agricultural community is located in close proximity to Mexico and is near a major interstate highway. Plans for widening the interstate are expected to make the region more desirable to developers. Small locally owned and franchise businesses cluster on either side of the main business highway. The tax base and tax revenues for the district are increasing with new industrial growth in the area. Seventy percent of households speak Spanish as their first language. For many years, schools in this community were part of the larger adjacent urban school district.

Martha was the case study teacher from the rural Texas site and taught at this school throughout her career, working in a first grade classroom her first two years, and then changing to the third grade. The type of technology-assisted constructivist learning environment that Martha exemplified may be characterized as a "Learning-Centers" model.

Texas urban. This site was set in a growing section of a central Texas city whose population is over one million and according to the *American City Business Journal*, the city is one of the fastest growing in the United States. The site school is a new elementary campus located near a major interstate highway. The area around the school is growing, as evidenced by the construction of new apartments and single-family homes. Although the school is in a newly developed area, an established mobile home park lies within the boundaries of the school attendance area. Children who attend the school are from primarily low-income families; eighty percent of the student population is classified as economically disadvantaged. Approximately 42 percent of the school's 510 students are African American; 40 percent are Hispanic; and 20 percent are White. Eighty-five percent of students qualified for free or reduced lunch.

Susan was the case study teacher from the urban Texas site and taught second grade. She had transferred to this new school along with its principal, after teaching for eight years in another elementary school. The type of technology-assisted constructivist learning environment that Susan exemplified may be characterized as a "Cross-Grade Collaboration" model.

Appendix 2

Arkansas Case Study: Roberta

A "Project-Based learning" model
of a technology assisted constructivist learning environment

In Roberta's case, "project-based" learning describes small, collaborative groups of students studying particular content by collecting information from multiple sources and creating multimedia projects to share the results of their inquiry. Examples of these projects include the study of aspects of medieval life and particular states. Roberta facilitated the students' work as they studied these topics and developed their projects. Using project-based learning was a means Roberta used to include all students and to help manage student behavior. Active engagement of students in collecting and analyzing information from multiple sources and creating multimedia projects was Roberta's approach to creating a constructivist learning environment supported by technology.

Community Context

This case study is set in a rural Arkansas community of approximately 6,000 residents, located in the foothills of the Ozark Mountains at the edge of a major river. Most of the residents are white and have lived in the community for generations. Roberta, the case study teacher, noted that there are " some very old families here that have been here since the town's beginning," although the community is beginning to have "newcomers." Most of these new residents have moved to the community from other areas in the state; very few have come from other states or countries.

An analysis of the town's workforce by the state's Economic Development Commission reflects the blue-collar nature of the community's available labor force. The local economy is primarily supported by agriculture, logging, small industry, and tourism.

District and School Overview

The school district includes one high school (grades 10–12 with 400 students), one junior high school (grades 7–9 with 500 students), an intermediate school (grades 3–6 with 570 students), and an elementary school (grades K–2 with 450 students). The district supports 137 teachers and an administrative staff that includes the superintendent, a part-time curriculum specialist, and a technology coordinator. Like Roberta, almost all of the staff are white. The teachers describe themselves as an "old" faculty, in that many of them have taught together at this district for 20 years or more.

The school district serves a student populace of approximately 1,900. Students are primarily white (97%) with a small representation of African Americans (2%). Hispanic, Asian, and Native American students collectively comprise less than 1 percent of the student population. Over 50 percent of the district's students qualify for free or reduced lunches. From the 1997-98 graduating class, only 40 percent enrolled in a two- or four-year college.

At the beginning of the ATRL project's work in the district, there was a focus on reading improvement in response to a low ranking on the Stanford 9 Achievement Test. In their 1997 scores, more than half the students ranked below the fiftieth percentile. In the eighth grade, 29 percent of students scored below the twenty-fifth percentile in reading and 32 percent scored below the twenty-fifth percentile in language arts. Using grant money awarded by the state, the school purchased the Accelerated Reading program, which uses a computerized system to track student completion of reading goals. The program emphasizes a school-wide reward system for reading from a large group of selected titles.

School site. Roberta teaches in the district's intermediate school. It is a ten-year-old facility located on a campus next to the county fairground along with the junior high school and high school.

Technology resources. The district prides itself on the technology innovations it has undertaken through the years. In the late seventies and early eighties the school's computers were located in the business department and in IMPAC (Instructional Microcomputer Project for Arkansas Classrooms) labs that provided computer-assisted instruction for mathematics and language arts.

In the late eighties and early nineties, community businesses supported computer upgrades for selected classrooms and an internal district network was established. In 1993, the high school acquired Internet access as a pilot school for the state's Public School Computer Network. Teachers, volunteers, and students installed the equipment needed to accommodate that access. With the full implementation of the state's electronic network, the entire district was linked to the Internet.

The district has three servers (two campus-wide and one dial-in server that hosts web sites and listserves), 144 networked PCs located in classrooms and offices, 30 PCs in the IMPAC lab, and 27 computers in an Apple lab. The district also has acquired a variety of software and hardware, including scan converters, digital cameras, flatbed scanners, external/removable zip drives, and printers. This equipment was chosen to support an effort to move to a project-based curriculum that provides students with experience in writing, publishing, and multimedia presentations. The district supports a full-time technology coordinator who is responsible for network maintenance, individual computer installation, software troubleshooting, and initial training for computer use.

There are computers in each building in the teacher lounges and libraries. However, computer access is richer for some buildings than for others. While Internet connections were installed throughout the district in 1995, not all classrooms have computers. This case study teacher's classroom had a desktop computer connected to a local area network and the Internet available when the project began. Software available included a suite of productivity tools, such as word processing, database, and spreadsheet software, and Accelerated Reader software.

Introducing the Teacher – Roberta

Personal background. Roberta grew up in a town just 13 miles from the community in which she has taught for the past twenty-one years. She still resides in her hometown. Except for two years of her teaching practice, Roberta has taught fourth grade students.

Motivation, philosophy, and experience. Roberta credited her approach to teaching to a former teacher and experiences early in life:

> "I had a really good high school history teacher. And that, I think, created an interest in history. So, that created my love of social studies, which is one of the subjects I teach, other than reading."

> "As far as the way I teach, I am probably most affected by Head Start. I didn't go to Head Start, but my mother was a Head Start nurse. So, I spent lots of summers with her in and out of day care centers, the Head Start centers. I saw how they approach teaching young children. So, when I started that's all I was going to teach, kindergarten children. That's my area and I loved it. And I love the eclectic way they taught by bringing in everything. That's what I thought I would do. I still tend to teach the way I was taught to teach kindergartners, bringing in stuff. And teaching like, what we would call it when I was in college, unit based, where you are teaching all the subjects around one thing."

Roberta described her students as "a very diverse group in some ways." This diversity takes the form of economic differences and differences in family structure. She described some of her students "the upwardly mobile, the well-to-do kids who come from a fairly stable home life who have wonderful experiences behind them." She said she believes these students are "ready to learn, ready to be there." Other students come from homes Roberta described as

> "Just a mess. They're a mess because [the children] can't fight that and neither can we. And they come with totally different experiences and concepts and ideas of even themselves."

Roberta said there is a larger number of these students in her classroom now than when she began teaching some 22 years ago:

> "I'm seeing more of the really, severely disturbed that have major problems that you can't help. It is sometimes it's a real struggle to mesh those all together . . . They just seem to be less innocent than they were when I started [teaching]."

These changes in her students represent a challenge and a frustration to Roberta; she said:

> "You get this pressure to kind of become mama and daddy and take care of every single problem that they have. And there is a time when you break your back trying to do that and one day you realize you can't fix everything. You can't fix what's going on at home. And you have to kind of make this a safe place, where at least it is comfortable and learning can take place, and they can feel comfortable. And it's a safe haven for some of them. And go from there."

Although she teaches fourth grade students, Roberta explained that she does not teach all the core subjects to her students:

> "We went to what they called "Team Approach" and so, I teach with three other teachers. And we have the same set of kids. We are what we call semi-departmentalized and all I teach is reading and social studies. I've done that now for five years. The five years before that I taught just social studies. We were totally departmentalized. Before that I was totally self-contained. So, I haven't been in a self-contained class for quite a while."

Baseline Information

Project participation. Roberta reported that she decided to participate in the ATRL project because she had become too structured in her teaching over the years:

> "I felt myself becoming more book oriented and kind of 'Sit-in-your-seat, me talk a little bit, you respond' kind of stuff . . . That was traditionally not the way I did it, but as the years passed I found myself going towards that and so I thought 'No, that's not really how you have always done this'."

She posited that the reason she had fallen into this form of teaching was difficulty with classroom management:

> "If you have a difficult year with several difficult students or just a difficult time from, you know, your personal life or whatever, it's easier to do that because that's more manageable. The other way, it's harder as a teacher because . . . you've got to be organized or it doesn't get done properly, you have to have cohesion in it."

Coupled with her desire to go back to less structured classroom practices, learning how to use the computer as a teaching and learning tool led Roberta to get involved in the ATRL project:

> "At first I was using it as a grade book program, that's the first thing I guess I actually used it for. We were going to be using it for this reading program, and I thought I don't know enough to use it for anymore than that. I had five computers and it was going to be used for Accelerated Reader, and that's it, and that's a waste. We have a lot of fourth grade students, but still there were going to be times when it wasn't going to be used. To me that seemed a waste, for it not to be used for something else, and I didn't feel comfortable using it any other way, except maybe with word processing. But as far as a research tool, or something like that, I didn't feel comfortable doing that."

Experience with technology. Roberta described herself as "totally computer illiterate" until the school put computers in the teachers' lounge:

> "They put two in our lounge and I just started playing with them. And it kind of grew from there. It started out basically with stuff that made my job easier. The paperwork kind of thing."

Roberta did not have a computer at home when the ATRL project began.

Using the computer as a productivity tool in her work helped Roberta develop some computer skills. On her initial self-assessment of computer skills, Roberta scored herself as experienced or having some experience in 23 of the 86 skills listed. These skills were in the categories of general computer use (e.g. turning the computer on/off, using a mouse, saving and printing documents), word processing (e.g. entering text, highlighting, copying, pasting and formatting text), use of a web browser (e.g. navigating the web by links, creating bookmarks, using a search engine), and use of electronic mail. Roberta reported that she had no experience using databases, spreadsheets, or presentation software. She noted that she wanted to learn about every skill listed on the checklist.

Roberta reported using the computer she had with her classes, but this use was limited to the Accelerated Reader program in place on her campus. This program requires 60 minutes of reading by each student each day. Students read books and then take computerized tests to determine comprehension of what they have read. A reward system based on the number of books read is another component of this program.

Initial observation. During the baseline observation, Roberta's classroom seemed a colorful and friendly place. The walls were covered with many posters and maps. Plastic globes and globe balloons were suspended from the ceiling. Classical music played softly while the children read silently at their desks. Roberta moved about the classroom, checking students' individual written work. A "Reading Garden" area was located at one side of the room as a place for children to sit on the floor and read. Student desks were clustered in groups of four. Of the twenty students in the class, eleven were boys and nine were girls. One child was Hispanic, all the others were white.

During this time, the technology coordinator was in the room installing four new computers that had just arrived that day. Roberta received these computers from the district after writing a mini-grant proposal describing how she would use them with her students. The purposes she described were linked to the Accelerated Reader program.

After about 15 minutes, the students began to be distracted by the work of the technology coordinator. Roberta ended the reading time and told the students to take out their social studies worksheets. She asked the students to trade papers and began a general discussion and review of some geographic definitions. The class was once again on task with academic work while the installation of computers continued.

"Who can name the continents?" Roberta asked. A student responded correctly and Roberta asked further questions about the oceans and the equator, pushing the students for exact answers.

The class then began correcting the worksheets as Roberta asked for the correct answers. One student questioned the correctness of North versus Northern for a question regarding hemispheres and Roberta clarified this for him.

Another student asked if the paper she was grading was correct when it stated that Africa is in the Northern Hemisphere. Roberta turned the question to the class: "Is there anything wrong with that answer?" A class discussion ensued, employing the world map on the wall to note where the equator falls in Africa and in which hemisphere Africa lies.

The First Year

Early experiences and perceptions. In the first several professional development sessions, Roberta was quiet and did not offer ideas to her colleagues. She actively participated in the sessions, but was not outspoken. She was one of team of fourth teachers who worked together closely on a daily basis. All four of these teachers participated in the ATRL project and as they worked together, Roberta's confidence seemed to grow. She reported her surprise at the students' skills with computers and how quickly they learned to use the technology. Over time Roberta began to participate more openly in the professional development sessions, raising issues and providing examples of activities she had tried in her classroom.

Designing instructional activities. Once Roberta had access and had developed some skills and strategies for managing technology in her classroom, the Internet provided an important external resource. The unit plan she shared with other teachers at the end of the first year of the ATRL project incorporated her desire to bring content together around a theme and to return to the more learner-centered approaches she had used when she was first teaching. The unit also included the use of several technology applications. The Internet was used, along with works of literature, non-fiction books, and magazine articles as resources for students as they conducted research on topics about life in medieval times.

Students worked with partners or individually, depending on the student's preference, and did research and writing tasks in both Roberta's class and the classroom of a colleague. The unit lasted three weeks in both classes. Students used a word-processing program, a presentation program, a multimedia program, the Internet and a digital camera to complete the projects in the unit.

The unit plan explained that the teachers first taught the students how to use the multimedia program and a digital camera, and how to add pictures to a digital presentation. Some basic formatting skills for word processing (e.g. setting margins, changing fonts) were also demonstrated for the students. Each group (or each individual student for those who chose to work alone) was required to create a multimedia presentation and a written report about the topic that they selected for study.

Roberta and her colleague shared the plan and the resulting student products with the other teachers participating in the ATRL project and reflected on what the students had learned, the benefits of the project, and the drawbacks to this type of activity. They felt the activity had gone well and that the students had learned several technology skills as well as the content under study. The time it took to prepare and conduct the project was the primary barrier.

The other teachers were positive in their feedback to Roberta and her colleague, as reflected in these comments:

> "I think the blend of computers, books, magazines, and art projects is great. I know the kids loved it!"
> "I particularly liked the theme of medieval times and how both writing and history were incorporated into the projects. I plan on using some of the multimedia techniques with my students."
> "Every student had a chance to use a hands-on approach to learning. This allowed a wide range of student creativity."

End of year progress. During the observation of Roberta's class at the end of the first year of her participation in the ATRL project, there were indications that she had begun to give students more control over their own learning. Routines seemed to be clearly established. Instructions were written on the board and students looked to those as they entered the room. Several students immediately took seats at the five computers located on one side of the room. One student stood behind others as he observed their work on the computer. Some of the students were completing Accelerated Reader tests while others typed stories assigned by another teacher. Roberta and this teacher were collaborating on an interdisciplinary unit.

As during the initial observation of Roberta's class, there was music playing softly in the room. World maps were still on the walls and globes displayed. Student-produced graphs were now posted on the walls, demonstrating the results of a data analysis activity. The desks were clustered in groups of two or three and two students reading independently occupied the Reading Garden. Roberta did not address the class with instructions. Rather she moved about the room, assisting students in the variety of activities going on. The class left the room for a visit to the school library after about twenty minutes to collect information for a project.

Roberta reported that she continuously seeks to find outside resources to bring into the classroom. She said she values the new perspective brought into the classroom by her subscription to *National Geographic* magazine and artifacts from her personal travels to other states and countries. "There are some real stubborn myths that are still believed about other cultures." Roberta noted that outside resources could help dispel some of these myths and expand the limited cultural knowledge held by her students.

The Second Year

Using technology in the classroom. By the end of the project, Roberta rated herself as experienced or having some experience with 57 of the 86 skills on the self-assessment of computer skills. She reported having used a digital camera and computers in her classes for word processing, multimedia projects, the Internet, and the Accelerated Reader program. She also reported that she now felt confident enough to teach colleagues about general computer skills and word processing. Indeed, during a staff development day for the faculty across the district who had not participated in the ATRL project, Roberta presented a session entitled "Introduction to Computers and the Internet" in collaboration with other teachers on her fourth-grade team. The flyer these teachers created to advertise their session described it as follows:

> "Come to our session and discover how a mouse got caught in a web. Learn how to find and keep good Internet sites, by book-marking these in a list of favorites. Our session includes hands on activities, with take home materials for use in your class."

Roberta reported that her goal had been to become:

> "comfortable using certain programs or some Internet research in my social studies area . . . I didn't want to get on and just search around and waste lots of time. I needed to have a system or way of doing that I didn't know."

That is what she noted as one of the most helpful aspects of the ATRL project, "discovering ways of using [technology] efficiently in a classroom of 25 kids."

Roberta spoke highly of the impact of the Accelerated Reading program on her students. She reported that she had been skeptical of the program:

> "When we got to see the lady who developed it, she told about making up the test books, and I said, 'How in the world could it be fun to read a book and take a test?' I don't get it."

After implementing the program, however, Roberta noted that she feels it works for her students:

> "I truly don't understand why it works. I understand the fascination with the computer. They do anything right now to get on the computer. But, I would say over one third of my kids have computers at home and they are on them all the time. So, the newness has to have worn off by now with playing with that computer. But, I've never seen anything work like it."

Designing instructional activities. In terms of instructional practices, Roberta described some of the changes she made to return to the more learner-centered approaches she used early in her teaching career. She noted that she is a co-learner with her students:

> "Right now we're studying the Southwest and talking about petroleum. It's fascinating the things I didn't know and they didn't know."

To elicit students' prior knowledge, Roberta had the students work in small groups to brainstorm all the items they had at home that are made of plastic. She then reconvened the group for a discussion of the role of petroleum in making plastics:

> "They were very surprised. They're fascinated that their sneakers or their clothes come from a petrochemical, which comes from petroleum. We also talked about natural rubber and synthetic rubber and why and how we needed to come up with a substitute."

The final lesson plan Roberta submitted indicates that she was continuing to use the multimedia software she used during the first year of the project, as well as the Internet.

She added a new instructional practice to her repertoire of managing learner-centered practices supported by technology in the classroom. Rather than teaching all students the basics of using the software as she had done in her previous unit, Roberta "randomly paired the students in groups. Several students were taught how to use the software and then they taught the others." This strategy, labeled the "Navigator Model" in the ATRL staff development session, was modeled during a professional development session Roberta attended earlier in the year. Small groups of students created multimedia projects to demonstrate their knowledge and understanding of states in the southeastern region of the United States. Students conducted research about the states using the Internet, books, and other materials.

Final observation. The integration of technology and learner-centered practices was evident in the final classroom observation in Roberta's classroom. As in previous observations, the room was full of maps, globes, boxes of materials and pictures, and the walls were covered with posters. The desks were clustered in groups of seven desks — larger groups than in previous observations. During the observation, the students were presenting information collected about a state that they had selected for study. Roberta asked students to share what they believed was "something interesting about your state." Students appeared eager to share what they had learned with the other students in the class. As the students reported the information, Roberta interjected questions such as "Why was he called Billy the Kid?" "How could the London Bridge be located in Arizona?" to encourage the students to think more deeply. The information the students had collected was used to create the multimedia projects described in Roberta's lesson plan above.

Looking Back, Looking Ahead

Roberta's increased computer skills and use of computers in the classroom emerged gradually over the course of the project. She reported that before the computers were placed in her room she did not want to learn to integrate technology. She felt she had only ten more years left in her teaching career and thus didn't need to learn to use technology:

> "But, it doesn't let you. [Technology] just keeps pushing in the door. I saw the world changing around me. And I'm basically curious about things, even though, I have this other self-protective part."

Roberta pointed to several things that contributed to her increasing computer skills and use of the computer in the classroom. Time to explore on the computer was one important element:

> "I got the opportunity to have a student teacher who was in my room. The school put [a computer] in the lounge and I just start playing with it. Literally playing with it. And I thought, 'Wait a minute, I can do too many things with this.' Once I discovered what I could do, what I needed to do as far as me and my kids, there was no turning back."

More knowledgeable colleagues created an important support system:

"I've been very lucky that I have a couple of people that teach in fourth grade with me that were much more computer experienced than I. So if I got stuck I could run to them."

This support was important to her because the technology coordinator in her district was "stretched too thin." Roberta said she has learned to call on more computer savvy colleagues when she needs immediate assistance. "If we hadn't had a couple of people in the building, we wouldn't be where we are."

Another factor that contributed to the integration of technology for Roberta was her sense of its usefulness:

"At first you think, 'This isn't any benefit' and then when you're typing a test at ten at night, you think, 'yeah, this is a whole lot easier.' Because I never used the typewriter, so just the word processor alone . . . I don't know what I would do without that. I say I couldn't teach anymore, but I guess we all could . . . And initially it was harder work for me because I was at it all the time after school — in between, at home— and you think, 'This is more work than without it'. And yet I finally reached a point when it wasn't. I got a system set up to do things and it freed up some time."

The greatest barrier for integration of technology for Roberta, she reported, was the level of her own knowledge and skills:

"The hard part is the teacher becoming comfortable using it herself . . . If I want to try something, but I'm not comfortable using it and I don't know what to do, I'm not going to do it with [the students] until I am . . . If you don't find the time and place where you can play with it and be comfortable with it and see what you can do with it, then it sits over there on a corner and it's not used."

Once she learned enough to feel confident of her skills with technology, Roberta needed new ways of managing her students:

"When I'm using the computer I usually break them up in small groups and that's usually easier to manage. They're more interested in working together. Because they love to work together, they are usually better behaved. You have problem kids who are usually easier to manage when they don't have to sit in one place for so long. When you break things up they get to move, and you're moving. You may do one activity for twenty or twenty-five minutes and then you stop, and you do another activity."

As Roberta looked to her future practice, she said that she wants to:

"become more creative and more efficient at the same time . . . I want [my students] to be creative learners and creative thinkers and creative problem solvers, so that, they learn ways to do that in my classroom. They are going to have to be creative problem solvers to survive, to flourish. I want to be more open, more flexible, more willing to try new things."

Discussion and Conclusions: A Project-Based Learning Environment Supported by Technology

Roberta's first formal classroom observation indicated that she had a low technology, moderate constructivist classroom. Although the classroom activities were teacher-directed for the most part, her questioning strategies actively engaged students in reflection and problem solving. There was one computer in the room and four were being installed the day of the baseline observation, but students were not observed using the computers for their daily work or special project work. Roberta reported that students use of computers had been limited to taking Accelerated Reading tests. She reported that she had not yet learned how to use her multimedia computers for other types of classroom use.

By the second formal observation, Roberta's classroom was still in this classification, although further along the continuum from low to high constructivist practice. Students were more independent and Roberta was more of a facilitator. At the end of the two-year project, Roberta was regarded as "moderate" in technology use and "moderate" in constructivist practice. Roberta's final classroom observation indicated that she had added many more elements of constructivist practice than in her previous two observations, yet not enough to be classified as high in constructivist practice.

Her classroom may be characterized as a "project-based learning" model of a constructivist learning environment. This description of Roberta's practice emerges as a result of formal and informal classroom observations, lesson plans, interviews, field notes, and self-reported data collected over the two period of the ATRL project. Roberta elected not to complete a TLC survey and thus that data is missing from this case study.

The term "project-based learning" is a term frequently used for defining or describing constructivist classrooms. The term is interpreted differently by various groups, ranging from problem-based learning to a classroom where individual students complete projects. In Roberta's case, this term describes small, collaborative groups of students studying particular content by collecting information from multiple sources and creating multimedia projects to share the results of their inquiry. Examples of these projects include the study of aspects of medieval life and particular states. Roberta facilitated the students' work as they studied these topics and developed their projects.

The following paragraphs discuss Roberta's instructional practice in terms of specific elements of technology-assisted constructivist learning environments. These elements were identified from the research literature and were incorporated into the observation protocol used by ATRL staff in collecting classroom data.

Teacher's Role. In her first classroom observation, Roberta demonstrated the following characteristics of a constructivist learning environment in working with her students:

- Validates and shows respect for all responses.
- Inquires about student understanding of issues or concepts before offering his/her own understanding.
- Provides multiple ways of learning.

- Asks open-ended questions requiring multiple answers and development of multiple levels of thinking.
- Seeks elaboration and exploration of students' understandings to elicit reflection.
- Establishes a positive rapport with students
- Acts as a facilitator and/or co-learner (guide on the side).
- Encourages student autonomy and initiative.

Roberta moved easily among her students during this observation. She seemed friendly and nurturing toward the students. When they became distracted by the installation of computers going on during class, Roberta shifted the activity to engage them with a learning task again. Her questioning strategies stimulated student problem solving and reflection around an incorrect answer. During a class discussion of geography, Roberta asked follow up questions to encourage students to get to correct answers, rather than providing the answers. She demonstrated her respect for students' answers even when incorrect. She employed maps and globes along with print materials during the class. In one instance where a student provided a wrong answer, Roberta turned to the class to help correct the error. Roberta used a map and asked additional questions to provide the opportunity for all of them to be involved in problem solving.

Subsequent formal and informal observations showed Roberta reflected the following additional characteristics in her teaching role:

- nests instruction within relevant, meaningful and real-world context
- elicits prior knowledge by encouraging the sharing of experiences
- stimulates thought and action through interesting, relevant, and authentic problems
- focuses on developing higher order thinking skills through problem solving and exploration activities
- provides opportunities for students to express ideas/experiences through electronic technologies
- allows students to collaborate with others during learning activities

During a discussion of petroleum products, Roberta asked students to brainstorm in small groups all the products they had at home made from plastic. This stimulation of student's prior knowledge helped to create interest in the topic under study and draw students' real-world lives into the classroom. Perhaps one of the biggest changes in Roberta's practice from when her classroom was first observed was the addition of technology as a resource for student use. Because there were not enough computers for all the students, small group collaboration was Roberta's means of organizing learning. Projects were her means for creating this collaboration. As noted previously, Roberta put students in groups to use technology and found that student interest was increased as they collaborated. These practices also helped her manage "problem students" because it created a more flexible classroom atmosphere.

Student Role. During the initial observation of Roberta's classroom, students:

- Used a variety of non-technology materials and tools for learning.
- Reflected upon the task at hand through class discussion.
- Were active participants rather than passive observers
- Recognized and used mistakes as valuable learning tools
- Showed evidence of understanding ideas and concepts

The students in Roberta's class read books and used maps and other print materials to understand the content under study. Through discussion, the students were able to reflect on the accuracy of answers provided by other students. When mistakes were made, the students engaged in problem solving to correct those errors.

Subsequent observations of the class indicated students in Roberta's classroom also:

- Used raw data, primary resources, manipulative, or interactive materials requiring interpretation
- Interjected relevant personal experiences and understandings
- Used technology to access information that is otherwise unavailable
- Became explorers, problem-solvers, or active participants rather than passive observers
- Engaged in different activities at the same time
- Raised questions for exploration or identified problems to be solved
- Designed methods for answering questions or solving their own problems

Roberta encouraged students to interject personal experiences and understandings through her questioning techniques. Students collected information about self-selected states from the Internet, books, and other print materials. The students knew the class routines and worked on completing projects while Roberta facilitated the variety of activities underway in the classroom at the same time. Through the completion of multimedia projects the students worked together to solve problems and create means for sharing the results of their research.

Curriculum. Two lessons were conducted during the first classroom observation. The first part of the observation period was dedicated to reading, while the second activity was devoted to social studies. These lessons reflected the following characteristics

- This session is framed so problems are meaningful and relevant to students.
- This session provides opportunities for self-guided exploration.

Students read self-selected books during the reading activities. When errors occurred students worked to find a solution, guided by the teacher.

- structured around complex or many-faceted themes
- part of a larger instructional activity that leads to multiple opportunities for learning

Projects were designed to draw upon students' previous knowledge and experiences and their interests. In the course of completing projects over several days, the students completed a sequence of activities that were part of a larger instructional activity. Students examined many aspects of the states they selected for study, each selected different aspects of those states to present as the most interesting to their peers.

Classroom. The classroom represented only one of the descriptors of a constructivist learning environment during the initial observation.

- This session emphasizes the activity of the student rather than the activity of the teacher.

The classroom activity engaged students in discussion around geographic elements. Rather than providing the facts to students, the teacher asked questions to solicit student ideas and stimulate their thought. The emphasis was placed on student thinking.

In subsequent observations the classroom was also structured to encourage social interaction. The following descriptors were in place in the classroom:

- provides opportunities for peer collaboration through discussion, project work and/or CMC.
- provides opportunities for collaborative/cooperative groupings or small group instruction

Students worked together in groups on projects on the states they selected for study. Roberta's lesson plans and her presentation to the other teachers in her district indicated that she was now providing these opportunities on a regular basis, to study medieval times, states, and other topics of interest to students. Students used the Internet as a tool in these studies.

Assessment. Initially, Roberta was able to employ

- on-going assessment that is interwoven with (not discrete from) student learning.

Through her questioning techniques, Roberta assessed students' understanding of geographic concepts while students were in the process of learning them rather than waiting for an examination at some later date.

Over the course of the project, Roberta's implementation of project-based learning, allowed for

- multiple ways to assess student learning
- students to be engaged in different activities at the same time.

Roberta now employed classroom discussions both during the process of students' collection of information and through the multimedia presentations students created about their states and aspects of medieval culture and life. These projects took place

over a period of several class periods. Other teachers commented on the level of these projects when Roberta shared samples during professional development sessions.

> "Students used material discussed in their classwork to help construct HyperStudio stacks. They were able to use any HyperStudio tool to develop their presentation. I was very impressed with the quality of their work. Collaboration between students was obvious since four or five students had to share computers. They were obviously in control of their projects."

School Context. Observations, interviews, and field notes indicate that the following school characteristics played a role in Roberta's development of a technology-assisted learning environment:

Peer support. Peer support played a key role in Roberta's change in practice. In her initial lesson plans, Roberta collaborative with a fellow fourth grade teacher. She assigned a high value to this collaboration in her interview.

Administrative support. Administrative support for Roberta's changes in practice came from the superintendent during the first year of the project. Her principal adopted a laissez faire attitude about these changes. While not standing in her way, the principal did not pressure teachers at the school to adopt learner-centered practices or use technology for activities other than the Accelerated Reading program.

During the second year of the project, however, a new principal was hired for the campus. He began sending administrative information to teachers via email, encouraging the use of technology. He also had high expectations for teachers' use of student-centered practices, in particular project-based teaching. "My principal now has been very supportive. Having a new principal also meant rearranging many administrative tasks in the building, which reportedly increased Roberta's stress level.

Technical support. Connected to peer support for new instructional practice, Roberta also reports that timely on-site technical support from colleagues was important to the changes in her practice. The district technical support person was able to provide help with major issues, such as the installation of the computers and software in her classroom.

Professional development. The school district arranged its in-service calendar to allow for six six-hour days of ATRL professional development during the school year. Over two years, this amounted to 36 hours each school year (72 hours total) of professional development for Roberta and twenty-four of her fellow teachers in the district. Roberta reports that the instruction from the ATRL sessions, along with follow up support and collaboration from peers helped her stay focused throughout the duration of the project. They also helped her to revisit teaching practices she had used in the past.

Technology access. At the beginning of the project, Roberta had one multimedia computer she received from the district and access to the Internet. She also received four additional multimedia computers as a result of a proposal she wrote to the district that explained how she would use computers in her classroom to increase students reading abilities.

Time. As noted previously, Roberta spent a great deal of time during her planning periods, after school, and at home learning to use the computer. She noted that once she had a system in place for using the technology as a productivity tool and managing the technology in the classroom, the computer made her work more efficient. She pointed out that lack of time to practice what was learned in professional development was a barrier for her and her colleagues. "Access used to be the biggest barrier, but now everybody has a computer in his or her room, so there is access in my building. It's just the time." In addition to her need to find time to practice what she learned in professional development, is the time Roberta is asked to dedicate to other school reform initiatives. She reported that finding time to attend all the professional development offerings for these initiatives in her district was difficult for her.

Critical Mass. In Roberta's district, 25 teachers from grades three through twelve participated in the ATRL project. Of these 25, three were Roberta's colleagues at the fourth grade level. This was the entire faculty at this grade level, creating critical mass. Roberta's progress in developing a project-based learning environment supported by technology was facilitated by this critical mass. She collaborated with her colleagues on projects supported by technology and called on them for help when she needed it.

Peer Support. Roberta noted that the support of her colleagues was important to the changes in her practice during her interview. She pointed out how essential it was for her to have someone across the hall who could help if she had technical problems with the computers in her classroom. The lesson plan Roberta submitted during the first year of the project was developed with another teacher at her grade level. Finally, the presentation Roberta made for other faculty not participating in the ATRL project was created and presented in collaboration with her peers as well. "I think pretty much everyone has been very supportive. It's been surprising. A couple of people that were not supportive in the beginning and suddenly they say, 'I see the value in that.' They've kind of been turned on. So I think we have come along way."

Pressure from external testing authorities- A new statewide testing program pilot tested in fourth grade caused Roberta to abandon some activities she felt were successful in the past. "It just seemed with the pressure from [test], I didn't have time." She notes that she is expected to bring up the scores of her fourth grade students, but gets mixed messages about how to go about accomplishing that. "You go to a meeting and they say, 'This is what you need to do' and then you go to another meeting and they say, 'no, you need to do this.' [We] have felt real frustrated by it." At the same time, Roberta feels the students are better writers because of the emphasis on preparing for the test.

Personal Attributes of the Teacher

Commitment. Roberta reported that she was looking for a means to return to the more student-centered approaches she had used earlier in her career when she began

participation in the project. Her training as an early childhood educator and her early life experiences influenced her beliefs about teaching and learning. She was willing to invest the extra time it took to learn both personal computer skills and new classroom practices that would allow her students to use technology for learning.

Technology skills. Roberta now regards herself as "experienced" in numerous personal computer skills. She understands the instructional value of computer technology and the importance of her students learning to use it. During the professional development sessions offered by the ATRL project, Roberta experienced ways of incorporating computer technology into a variety of classroom activities. Subsequent formal and informal observations during the first and second years of the project showed Roberta involving her students in collaborative learning activities centered on technology- based projects. Her self-assessment of her computer skills was moderate initially, but high by the end of the project.

Effective instructional designer/planner. Roberta notes that she plans activities for her classes based on what has worked in the past coupled with her perceptions of the students she has each year. "There will be a unit that I love teaching and the kids love and I just do it every year. But, it's never the same. There will be things that one class will focus on and that the other classes won't. So, they're always different."

Roberta also values the role of resources from a multitude of sources and brings those into her classroom. Artifacts from trips she has taken, her collection of *National Geographic* magazines, and the information available on the Internet are key resources in the project-based learning model she employs in her practice. "I'm constantly on the lookout. All year long, if I'm traveling, something catches my eye and I think, 'Oh, I can use that.' All the time, I'm searching for something."

Philosophy. As noted previously, Roberta espouses a philosophy that is "whole-child oriented." She attributes this philosophy to early experiences with her mother as a Head Start nurse, a high school history teacher, and her training as an early childhood educator. She reported that she decided to participate in the ATRL project to renew that flexibility and whole-child orientation she valued. Based on the students she has in class each year, Roberta modifies the topics and activities that will be conducted in her class.

Roberta also values external resources that she can provide to her class through artifacts she collects as she travels, her collection of National Geographic magazines, and the Internet. She believes these resources increase her students' interest in and understanding of other cultures and places. "You can get students interested in social studies because you can study the obscure or different, and they are usually fascinated with that . . .. I found you can actually interest them more with things outside the United States."

Expectations. Roberta held high expectations for her students. She included all of the students in collaborative groups to complete projects on the topic under study. She demonstrated respect for all students' answers, even when those answers were incorrect. She encouraged the students to work together to correct these errors through facilitated discussion.

Using project-based learning was a means Roberta saw to include these students and help manage student behavior. Active engagement of students in collecting and analyzing information from multiple sources and creating multimedia projects was Roberta's approach to creating a constructivist learning environment supported by technology.

Appendix 3

Louisiana Case Study: Jeanette

A "Collaborative Teams" model
of a technology assisted constructivist learning environment

In Jeanette's case, the focus is on students being active and engaged in multiple activities. Vanessa has extended the "learning stations" idea where each day represents a center, so that by week's end, students have rotated through all 5 centers and have worked on five different components of a Language Arts unit. Students are in charge of how they accomplish their tasks, how they negotiate roles, and how they divide labor and each day. In a verbal recapitulation, they assess themselves and the activity. Vanessa is a facilitator. She acts upon students' requests--intervening only when they have been unable to solve a problem on their own or have exhausted all other resources.

Community Context

This case study is set in a semi-rural community in the Acadiana region of southwestern Louisiana. A growing community of about 5,000, the town is rapidly becoming a bedroom community for a nearby mid-sized city. The community is mostly white; the only significant minority population is African American —36 percent of the total community according to the 1990 Census. The majority of community members identify themselves as Cajuns. According to the 1990 Census, one-third of households still speaks French as their first language.

The community's economic status is low-to-middle income. According to the 1990 Census, 17 percent of households receive public assistance and the median household income is $16,000. Educational attainment is also low. The 1990 Census reports that 36 percent of residents over the age of 25 have less than a 9th grade education.

The community traditionally been very independent, wanting to keep its distance from its larger urban neighbor. Geographically, the area is flat with numerous bayous and mangroves. Nearby is the Atchafalaya Basin, the largest wetland in North America. Because of the abundance of wetlands and the prevalence of Cajun culture, communities in the area gather much of their revenue from recreational activities such as birding, boating, hunting and fishing, and tourism.

The Cajun culture is still strong, and residents of the 22 parishes that form "Acadiana" in southwest Louisiana are proud of their culture and history. The cultural influences are ubiquitous. Southwest Louisiana shuts down for five days each year as residents celebrate Mardi Gras, a more rural and family-oriented version than that celebrated in cosmopolitan New Orleans. French expressions and syntax are evident in patterns of speech. Cajun music, and its African-

American counterpart, zydeco, are omnipresent, and typical meals include such distinctive regional cuisine as couche-couche, boudin, gumbo, crawfish étouffé and roast pig. The cultural influences, though perhaps less evident, are equally strong in terms of the ways in which people interact with and tease one another and in their faith and worldview.

District and School Overview

The parish as a whole enrolls more than 30,000 students at 41 schools, with a faculty of approximately 1,600 teachers. The student population is predominantly white (63 percent); 34 percent of students are African American, and one percent each is Asian and Hispanic.

School site. The site school is a middle school serving grades five through eight. It draws approximately 40 percent of its student body from the white, semi-rural population of the local community and 60 percent from a poor, predominantly African American section of a neighboring city. The school has a free and reduced lunch rate of 75 percent. As one of the poorest achieving schools according to scores on the Louisiana Educational Assessment Program (LEAP) test, is classified by the state as an "at risk" school.

Technology resources. In July 1997, the Louisiana Department of Education created the Louisiana Center for Educational Technology, whose goal is to provide all K-12 educators with access to technologies that improve student achievement. To achieve this goal, the state has focused on providing leadership and professional development. In addition to professional development provided by Challenge Grants (in 5 parishes) and at the parish level, the State Department of Education sponsors summer Teaching, Learning and Centers that help teachers use technology in a more student-centered fashion.

As one of five recipients of the state's Technology Innovation Challenge Grants, the parish has significantly increased its technology resources. A full time district technology coordinator provides software training for teachers, and two technicians provide troubleshooting support to the entire parish.

The 1997-1998 Quality Education Data ranked the site school as "medium" in its technology inventory. Every teacher has at least one Macintosh, PC, or Apple IIE in her or his classroom. The school was first connected to the Internet in late fall 1997; however, at the start of the ATRL project, fewer than 50 percent of the school's computers were connected. Of those connected to the Internet, a majority were housed in two computer labs. At the start of the ATRL project, only Language Arts teachers had more than one computer per classroom. All Language Arts classes (including Jeanette's classroom) had four networked PCs and a color printer.

By project end (1999-2000), the technology situation at the school changed markedly. All Language Arts, science, social studies and math teachers had "model classrooms": four networked computers, color laser printer, scanner, and

a TV/VCR. By project-end, only non-core classrooms (e.g., physical education) and special education classes had only one computer per classroom. Only special education classrooms—all of which are housed in portable buildings—had no Internet access. All other classrooms operate on both a LAN and WAN. Additionally, the school had three computer labs: a CCC lab, a PC lab and a Macintosh lab.

Introduction to the case study teacher - Jeanette

I can't imagine how I taught before. I think back to my own teaching and think, "God, how boring!" I would not want to have to have been in my class. It was awful. Now I see them interacting with each other and just learning and not worrying, "Is this graded? Is this a test? Is this important?" Now they just do the work and they're not worried about grades. They just want to do their best.

Personal Background. Jeanette teaches 6th, 7th and 8th grade Language Arts at the middle school, the only school she's ever taught in. She lives with her husband and three children in the local community. Many of her students are her neighbors.

Like most of her students and peers, Jeanette is Cajun. Though she knows only a little French, her parents are bilingual. Jeanette's life typifies many practices and characteristics of Cajun culture. She reported that she always celebrates Mardi Gras, makes gumbo for her family, sends her children to a religious school, and loves to "pass the time" fishing in the many area bayous.

Motivation, philosophy, and experience. Jeanette stated that she knows her students well and the personal and academic problems that confront many of them. She explained that she has always had a very close relationship with her students, a fact that seems to cause some ambivalent feelings:

"[It's] something that's good and bad. I always tend to get personally involved with all of my students. I think that really helps to connect and it helps them to learn. They don't come in scared or scared to ask questions...they know how I feel about things. They tell me things that I don't really want to know a lot of times, but I have a personal relationship with each and every one of them."

In her conversations with SEDL staff, Jeanette spoke of the challenges posed by working with parents who themselves have a low level of education, many of whom, she said, do not value the importance of a good education.
She described the situations of many of her students: one girl who was pregnant, another girl who lived in an orphanage, and one boy whose mother was alcoholic. Jeanette said she checks in with these students at various points to make sure they're doing all right. She noted that the educational system often ignores the needs of such "at risk" students and appears to have made an effort to let no student fall through the cracks in her class.

Jeanette didn't always have such a smooth relationship with students, at least in terms of discipline. When she began teaching, she taught in a fifth grade self-contained classroom; she started out with 28 students, but by year's end, eleven had been expelled:

"It was an experience; I wasn't prepared at all. I mean I was prepared curriculum- wise, but just discipline-wise, to sit in there with a classroom of students, I wasn't prepared for that."

Because of its low income and at risk student population, the school's ethos is one of discipline and teacher control. For the most part teachers are very strict. Students wear uniforms and ID badges, cannot leave the building for school activities, and are not allowed to use lockers. Jeanette reported that she ascribed to this approach when she first began teaching. She said it was important for her to exercise a great deal of control. She didn't allow students to

"talk or raise [their] hand…I was very strict . . . When I started teaching, they were in rows. I thought they listened. They did skill work and I walked around and I helped them out, but the children didn't talk. That was my idea of a perfect classroom; they stayed quiet and you taught, moved on to the next subject and taught. [I] evaluated their test scores, went back and re-taught."

Baseline Information

Project participation. Jeanette reported that she was initially reluctant to participate in the ATRL project. "I didn't want to do it," she admitted. She recalled that: her principal signed her up for the two-year project.

"He told me I was going to do it. I did not think that I would get that much out of it, I thought it would be like any other in-service that we have had. A lot of them are boring. You know, a person gets up there and lectures and it's not always something that you want to learn about or hear about."

Initial observation. The school's emphasis on a high degree of teacher control was evident in Jeanette's first formal observation by SEDL staff in the spring of 1998. Jeanette's class was silent; students sat in rows and worked quietly and individually. Jeanette stood in front of the classroom cradling her teacher's manual. She generated all of the conversation, and students were restricted to short answers. Though Jeanette had four computers in her classroom, none was on or being used by students. "

Like most of her colleagues at the middle school, Jeanette was identified in that baseline observation as "low constructivism" and "low technology." In spite of what she identified as a "very technology rich" classroom—four computers, a color printer, a scanner, TV/VCR and AverKey, and a digital camera—she never used this technology:

"I was scared to death of it. We really didn't use computers. The children took *Accelerated Reader* (AR) tests on them, and I let them go on and play spelling games. They couldn't go anywhere else, I had limited them."

She laughed, remembering why she wouldn't let students use the technology. "I didn't want [the computers] to get broken. I didn't think the kids could handle that." She also reported that she had "no interest whatsoever" in learning about or using technology. "I didn't want to change. I didn't want to lose control."

Experience with technology. Such reluctance and trepidation about technology may have been due in part to Jeanette's own perceived unfamiliarity with technology. An examination of the first computer skills checklist reveals that when Jeanette began the ATRL project she felt very experienced with some general computer functions, like turning the computer on and off, saving and printing files, and with software applications such as word processing. Beyond that she reported "some" familiarity and comfort with presentation software. Otherwise, she generally reported herself as having no experience with technology in general. What seemed to bother her about her skills relative to those of the students was somehow losing face—and ultimately losing control over them:

"I was the teacher and I was supposed to know more than they did. . . I remember my students coming in and saying, 'Can I go on the computer?' and I would say, 'No. We can do an activity later, but not now.' It was because I did not know everything, and I didn't want them to get on and say, 'How do you do this?' and I wouldn't know. But I learned."

Though she later came to rue the type of classroom she had at the beginning of the project, there was no external incentive to change her practices. The feedback she received from administrators was strongly positive. She reported that when she first started teaching the administrators would see her students working silently in rows and commend her on a "wonderful job." She explained, "That's what they are used to seeing and that's what they thought they should see."

The First Year

Early experiences and perceptions. Participation in the ATRL staff development began changing the course of Jeanette's teaching. Following the first two professional development sessions, teachers were asked to complete a letter of intent describing some change they would attempt in their classroom in the coming weeks. Though reluctant—she said she feared that students would do nothing—Jeanette resolved to let her students use the computers and try a group activity. This was the beginning of the change in her practice, although she described the change as very slow. She liked to have control, she reported, but began to see that the student-centered tactics were working better than her traditional tactics. Jeanette started by letting students work individually on a computer while she taught the rest of the class. Soon she began to pair students on the computer.

The change process, first centered on technology, migrated to other areas. Jeanette began to give students a choice of activities to work on. This too "worked well" and she began to share her successes with colleagues and in turn receive other ideas from them. Soon she began occasionally to allow her students to work in groups:

"It was really hard to let go. But I did it a little at a time and teaching became easier. Every time I'd let go it was okay. The students accomplished their goals and slowly gained more and more independence and as they did their work got better and better."

Not only did students' academic performance improve, so too did their behavior. Jeanette reported that she learned how to give them positive reinforcement and that they in turn learned how to do this with one another. She claimed that by letting students have more autonomy in terms of activity choice and working together, students improved their social skills. "They learned how to cooperate and be part of a positive learning environment—essential life skills according to Jeanette.

Jeanette reported that the professional development sessions allowed her to become more confident about using technology, and she learned about student-centered approaches from both SEDL facilitators and from her peers. Most valuable about the sessions was the "time to talk and share ideas," and the fact that all activities were hands-on, immersing teachers in activities as if they were students:

"We didn't have to sit there for three hours and listen to someone. We sat at computers. We felt like students. We felt their frustration sometimes—not knowing what to do and having to follow directions."

Perhaps from a control standpoint Jeanette learned to become comfortable experimenting and failing: "If I try and it flops, it flops." This realization, she said, helped her to revise the way she had been teaching.

Jeanette was unabashed about the benefits, indeed the necessity, of active types of professional development:

"A lot of times, we have these 'big wigs' who come and talk at us and tell us what we should be doing instead of having a teacher who says, 'Okay, this is what we're going to work on today and you'll do it and I'll help you now.' We learn so much from a peer and watching them in action."

Further, Jeanette noted, such hands-on staff development made her realize that learning could be fun. "We had a blast in those sessions. We learned as students."

Designing instructional activities. Jeanette appeared to be an eager "student" and immediately began to implement some of the strategies and skills she learned in the ATRL professional development activities. When ATRL staff members made the first follow-up visit to her classroom in September 1998, Jeanette's students were indeed in groups working together on a particular assignment. Staff also noticed a chart on the wall next to her four computers. Jeanette explained:

"That's my new management system. I learned that from the article you gave us to read."

Few of the other teachers had even read the optional articles, yet Jeanette was already implementing their classroom management suggestions. At subsequent staff development sessions she always participated in large group reflections and shared activities that she had conducted with students. At the end of the year, she collaborated with the 7th grade science teacher on "Biography of a Scientist," a cross-curricular science and Language Arts activity that used HyperStudio, PowerPoint, the Internet, and Inspiration.

In this activity, science class students chose a particular scientist whom they wanted to research. The science portion of the activity—i.e., recreating and discussing the contributions of each scientist was conducted during science class. Research on the scientist's life and the actual report writing was done using MS Word, Encarta and the Internet in Language Arts class. Their reports finished, students then used PowerPoint and Inspiration to "distill" their reports into a short summary. Students made their final presentations, using either PowerPoint or Inspiration, in their science class.

Using technology in the classroom. In the project's first year Jeanette also seemed eager to learn as much as she could about the various technologies in her classroom. She asked for help using her scanner and compressing photos and asked for help making web pages. Though she did not end up having students make web pages, students used PowerPoint and HyperStudio throughout the year to make electronic presentations, in addition to regular use of the Internet and Microsoft Word.

Jeanette also credited technology as a vehicle for change in her classroom. The change appeared to occur in two areas: Jeanette's own feelings around control and attendant to that, the social interaction among students. Jeanette appeared to concede the technical superiority of her students early on in the project, and thus appeared to allow them to demonstrate such skills. Regarding social interaction, Jeanette, perhaps unwittingly allowed technology to be used as a vehicle for student collaboration. She first began by letting students work individually on computers, then began pairing them. Finally, she moved to allowing whole groups to work together on one computer. Such sharing of a scarce resource obviously involved a certain amount of compromise and negotiation.

While she noted that the use of technologies such as Word, PowerPoint, and HyperStudio, resulted in "awesome" projects, and that AR motivated students to read, it was really the working together and collaborating on the computer that she—and, she believed, her students—found most valuable:

"I let them be responsible for their projects—in middle school this is such a big thing—they think they're really big and can do things by themselves. When you give them that power, they can really accomplish it."

She also saw the technology as serving as a forum for teacher-student empathy and understanding. Recognizing the technological proficiency of her students relative to herself, Jeanette established a cadre of "trainers" in each of her classes. She credited her students with teaching her so much a bout technology. More important than the technology training, she noted, is the human lesson: "They get aggravated with you, and it reminds me never to get aggravated at them."

End of year progress. By the time of her second official classroom observation in spring 1999, change was evident. Jeanette's classroom was now classified in the "medium constructivism," "medium technology" category. Her 7th grade Language Arts class (her "toughest" class she claimed) was organized into four learning stations—one at the computer taking AR tests, another with Jeanette working on grammar, another doing silent reading, and another working out of a textbook. According to Jeanette, this was a modification of the learning stations idea that ATRL staff had modeled. Rather than have students rotate through one center several times in the same class period, students rotated through each center once a week. By week's end each student would have gone through all centers—poetry, literature, grammar, computer, and reading. Jeanette had recently begun to arrange her classes this way on a daily basis.

In spite of this arrangement, the students appeared to be tightly controlled; hence boredom appeared high and many kids were doing nothing. Regarding technology use, students went one at a time to the computers to take their AR test. Though students were organized in groups, there was little or no communication. Jeanette circulated from time to time among groups to make sure all were on task. She employed one good information delivery strategy—having students explain grammar to each other, instead of doing it herself. Staff noted at the time that she used good questioning techniques and had a very gentle manner with her students. It was apparent though that Jeanette was not pleased with the way she ran this class. At the end of class, she asked ATRL staff for any ideas or suggestions they could give.

Year Two

Supplemental training. Over the summer, Jeanette participated in the Louisiana Integrating Technology program (INTECH). INTECH is an intensively structured, 60 hour professional development program, which provides many examples of technology-based strategies that support and enhance curriculum. Like the ATRL project, INTECH focuses on classroom management techniques,

new designs for learning, best pedagogical practices, curriculum standards, and modern technology skills.

Jeanette described her participation in INTECH as pivotal in her development as an educator. What was truly helpful was "the hands-on and the teacher strategies and teaching the different programs like PowerPoint and HyperStudio and classroom management." Through INTECH, Jeanette also learned how to use, and received her own copies of, Inspiration, TimeLiner and KidPix, programs she would use frequently with her students in year two of the ATRL project.

Changing circumstances. Year two was a difficult year for the entire school faculty. The school lost two long-term, highly able administrators, gaining instead two novice administrators. Further, in a wrenching public meeting, teachers and students were reassigned to other parish schools in order to achieve greater racial balance. Indeed, Jeanette herself was almost bumped to another school. Consequently, the school lost a number of young, innovative staff and the majority of their honor students. The staff felt demoralized from the whole procedure and at times, many project participants, Jeanette included, seemed to take a step back in terms of their instructional practices and use of technology and to retreat to the comfort of traditional pedagogy.

For example, during a follow-up visit to Jeanette's class, ATRL staff noted that while students were working on three of the four computers, they did so individually and silently, and students at their desks worked in the same manner. Students seemed bored and unengaged. Jeanette stood at the front of the class and wrote on the board. Students gave short answers. Staff returned periodically to the class during that same day (Language Arts classes are in two-hour blocks of time). At one point Jeanette was reading a story aloud and the students appeared extremely bored: many had heads down, some were contorted in their seats looking as if they would spring up as soon as a bell went off, a number looked at the clock, many yawned. It seemed unusual for one of her classes yet seemed to be indicative of the difficulty of maintaining a student-centered environment without the requisite administrator support.

Jeanette talked with ATRL staff after that particular class. She mentioned this year's student body and their "behavior" problems and the lack of administrative support. Staff mentioned that they thought the students were extremely well behaved, silent in fact. Jeanette said it was perhaps because there was a visitor and students were on their best behavior. Staff asked for clarification on students' "bad" behavior and shared some student behavior experiences from other schools. Jeanette seemed shocked: "Oh no, they'd never do that…I guess we have really high standards then…I guess they're not that bad." This conversation may have given her a sense of perspective: She referred to it on two other occasions during the remainder of the school year.

Setting new goals and moving forward. After the first three days of the ATRL professional development in August 1999, teachers in Jeanette's school were asked to create a personal rubric in which they focused on one part of their teaching: assessing where they had been when they began the ATRL project, where they were now after a year, and where they wanted to be by project end. Jeanette's goal setting mid-project rubric is shown below:

Group Work Activities for Student

Level 1 - Put students in groups and gave directions. I was very much in control, but thought I was doing great because they were not sitting in rows and it looked great.
Level 2 - I tried to let go a little this year and each group did something different. The groups rotated each day and assignments were given weekly. I still taught the grammar group.
Level 3 - (Wow!)- I would like to give an assignment (real general) and have the students tell what they have discovered and share with the group. I would like to become a complete facilitator.

Control issues were dominant for Jeanette during the course of the ATRL project. She worked diligently during year two of the ATRL project to attain her "wow" and give more and more control to students. During one staff development session, she reflected on an activity in which she had students working in groups creating word-processed books. Instead of micro-managing them, as she would have done the previous year, she said, she left them alone to sort out the social and academic logistics by themselves. She remarked that they had done a better job without her oversight. "I wouldn't have done that last year. I wouldn't have felt comfortable."

For the most part, in observing Jeanette's classes both formally and informally throughout year two, she appeared to be moving toward her goal of becoming a "complete facilitator." As she did in year one, she still employed her learning centers, with each group engaged in different activities at the same time. Yet Jeanette tended more to the background, allowing students to take active control of their learning. Observation protocol notes reveal that she rarely spoke to the whole group for the whole hour of formal observation. Instead she went from group to group, listening, observing and offering suggestions as needed.

The following paragraphs describe some of the major changes Jeanette reported in her instructional practice in the project's final year. Information is taken from interviews and informal interactions, and is confirmed by classroom observations.

Organizing for instruction. Jeanette reported that shifting her practice to group work has allowed her to better get to know her students and to create a more open, intimate atmosphere. With students working in groups, she said she finds she has the time for one-on-one conversations with students. She also finds that

by circulating among groups and sitting with students in their groups that the formality between teacher and student is lessened.

Though groupings are a cornerstone of her practice, Jeanette noted that she does not start the year with her students working in groups. Rather, she said, she spends the first couple of weeks establishing order and rules and getting students used to the structure of her class:

"By putting them in rows and explaining rules to them and listening to them, that lets them know what's expected of them."

Jeanette reported that she also uses the first two weeks as a time in which to notice different abilities and types of personalities so that she can later create heterogeneous groupings.

Students often go through a period of adjustment with the switch to group work:

"At the beginning, when I switch from whole group to group work it's always a shock. They'll complain, 'Well, I don't like this group, and I don't want to do this.' I pretty much laid down the law that this is what we are doing, this is how you receive your grades, it doesn't matter whom your group is, you are going to have to get along with them. That takes about two or three weeks. After that you can come in at the end of the year, you can go to them and ask them, 'Did you enjoy this, and did you like group work?' and they'll go, 'Yeah, I wanted to come to this class every day,' and you'll see it when they walk in the door, 'I like this class. I was ready to come.' They'll say, 'Oh, I hate to sit in rows.' You hear from them what they like. They really enjoy it."

"You will have some who will get into circles and think it's social time. You just have to have ways of dealing with it. A lot of times, the students will not do well the first six weeks, but unless they see that they will not accomplish their goals they won't do well. They'll improve."

Though Jeanette said she recognizes that groupings are not an elixir for the prevalent problems faced by at-risk schools, they have furnished her with new approaches for addressing some of her more severe challenges. For example, she explained, she has many students who have had encountered academic failure. "I have students who are 15 in 6th grade and 16 in 7th grade. They're just waiting to drop out." However, she said, she does not give up on them, as she did in the past. Rather, she informs them that they will not drop out of her class or fail her class and that they will indeed learn, but paradoxically, that she will not impose any of this:

"I had one student who sat for two weeks and did nothing. Every day, nothing. He finally jumped in because the students were having so much fun that he didn't want to be left out."

Jeanette reported that the changes in her classroom have become routinized:

"The first five or ten minutes I'll get them started. If it's a Monday, I'll let them know what we'll be doing for the week. They're divided into different groups— I have a grammar group, a literature group, an art group, a reading group, and a writing group. Each student has a role in the group. Every day they move from group-to-group. They don't stay in the same group the whole week. After I do that they're on their own for the next two hours. I will walk around and monitor, if they have any questions, I'll let them know. I may spend more time with one group because they'll learning new skills, or just starting something new. I'll go over the rules, things like that."

Within each group, Jeanette explained, students assume a variety of roles: instructor, technology trainer, note taker, etc., depending upon the project. Roles rotate daily and vary according to each project. Students spend most of class time working in small groups to complete assignments as a team or leading discussions. Less time is dedicated to students working together as a whole class and still less time to Jeanette lecturing the class. In terms of specific daily activities, students spend time working on group projects, writing in journals, problem-solving in groups, writing and expressing their ideas with electronic technologies.

Designing instructional activities. Foregoing breadth for depth, Jeanette reported that she now teaches six-week units and links her curriculum to Louisiana's Language Arts content standards. The focus in her classroom activities appears to be on higher order thinking skills and authentic activities that link academics and real world situations to students' own experiences.

Jeanette explained that she designs all activities with the specific content standards in mind. She also administers a pre-test at the very beginning of the school year—a diagnostic tool to assess students' level of understanding in Language Arts. She uses data from two sources—the content standards and the pre-test—to design curriculum:

"I just make sure to cover all the content standards, and a lot of times we really don't get through all we need to get through, but we just do the best we can. At the beginning of the year I kind of map out what I will do for the year, by six weeks. The first six weeks I will look at what we need to do for that six weeks and plan out a weekly schedule. Sometimes we may fall behind, and the first six weeks may lead into the second six weeks, and sometimes I may decide that I do not need to cover this as much as I need to cover something else, so things change."

Jeanette explained that the curriculum is driven by her students' skills, interests, and needs as well as by the content standards; she appeared willing to tailor it based on students' learning preferences and skills:

"It all depends on the students. I cover the skills that have to be covered, but it may not be the same for each group. Sometimes I have a group that is really creative and everything is an art, a play, and that's how they learn best. Sometimes I have a group of students that if they write everything, that's the only way they'll get it, or if they read to each other, that's the only way they'll get it, so it just really depends on the students."

Jeanette noted that she spends a good deal of up-front time making students feel comfortable. She spends "a lot of time" at the beginning of the year doing journal writing:

"I find that's the time when they will tell you everything and they'll write freely, because they are refreshed from the summer, and they want to write."

In order to better know her students, she reported, she also has them create a life map from the time they are born until 7th grade:

"After they draw their map, each map has a picture of an important part of their life. It looks just like a road and the car just travels the road, and sees the different things that were important to them, and they'll use the map to write a short autobiography. And I'll learn a lot from that: home life, school life, what kind of person they are."

To make her students feel more comfortable about the mapping activity, Jeanette said she shares with students an example map of some of her own major life events. Jeanette also said that she talks with her students informally:

"A lot of times I'll come in and tell them about things that have happened to me the night before or the day before. That helps them open up."

For her year two ATRL unit, Jeanette collaborated with the 6th and 7th grade science teachers and the 8th grade math teacher in "Siddaka and the Thousand Paper Cranes," a cross-curricular and multi-age science, social studies, study skills and Language Arts unit. In this unit, students read the novel *Siddaka and the Thousand Paper Cranes*. The study skills students researched Japan's role in World War II and the bombing of Hiroshima and Nagasaki. The science class studied the causes and effects of nuclear attacks and cancer. Other activities included origami, writing haikus, and the study of Japanese culture. Jeanette's students wrote haikus and used Encarta, Word, PowerPoint, and PressWriter for this unit.

Using technology in the classroom. Technology, which Jeanette described as an "essential" component of her classroom, is used by students for self-expression, to discover ideas and information, to analyze information, work collaboratively and independently. The most common software applications employed in her classroom are MS Word, Accelerated Reader, PowerPoint, KidPix, HyperStudio, the Internet, TimeLiner, PressWriter, PrintShop and Encarta. Jeanette also won an AlphaSmart at a conference in Spring 2000 which students use as an extra

word processor. At the time of this case study, she was working on a grant to procure 20 for the school's Language Arts department.

Technology use in Jeanette's classroom centers around groups. Every day, two groups—the reading group and the writing group—have primary access to the four computers. The reading group works on its reading assignment and uses Accelerated Reader to take a computerized test. Each student takes the test individually and tests last only about ten minutes. Students receive points for each book they read and use the points in Jeanette's class for treats. Jeanette states that students "love" AR and that their reading scores have improved by several grade levels. She is much more positive about AR now. Two years ago, she says, "I wanted to throw it in the trash."

The writing group uses MS Word (primarily), PowerPoint, HyperStudio, PressWriter or KidPix to complete their writing projects, which they may then post online at KidPub. Typically writing group students pair up or work in threes on two computers, each person taking turns on the computer while the others do over-the-shoulder editing or technical support.

The fourth computer, and now the AlphaSmart, is open for any other groups who need to use them. To ensure equity, Jeanette maintains a sign-up sheet which groups can use to reserve blocks of time within the two-hour class period to use Internet or Encarta for research, for example, or type a written assignment in the AlphaSmart.

Because each group rotates every day, all students, by week's end, have had a chance to use technology in a multitude of fashions—for assessment, writing, and research. Students also use ancillary technologies—the scanner to add their drawings to a poetry notebook and digital cameras to add images to their writing.

The greatest benefit for students using technology in her class is the same benefit that Jeanette herself received in SEDL and INTECH workshops: "the active hands-on" as she calls it. Students are proud of the reports, slide shows and projects they produce with technology and are consequently more motivated to read and write when technology is involved. Most important, their work has improved. Jeanette also speaks of the great social benefits of using technology in her classroom. Because students, like teachers, must manage scarcity (i.e., share four computers among 25-30 students), they learn to compromise, negotiate, husband their time, and collaborate.

Final observations. Jeanette's classroom in the final ATRL formal observation was noted as characterized by "high constructivism" and "high technology." Unlike the previous year, students seemed far more interested in their activities and more students were at the computers, using Microsoft Word to compose their autobiographies and AR to take reading tests. Jeanette appeared very enthusiastic about students' ideas, always encouraging and praising them, and

like the previous year, employing good questioning techniques. She also resisted micro-managing students. When one girl pressed her for explicit directions on how to create her mythology report, Jeanette said, "It's up to you. Just do it neatly."

In an informal classroom observation later in the year, Jeanette employed the same classroom management technique and the same style with students ("You can create your book covers however you want"), this time with even more use of technology: an AverKey that she had recently won at a conference and a digital camera, in addition to Accelerated Reader, the Internet, PowerPoint and Word. She mentioned that it was not unusual for her to use multiple technologies, referring to her classroom as "technology rich."

In both classroom observations, the only time Jeanette addressed the whole class was at the beginning when she explained the day's assignment and at the end of class when she asked for feedback: "What did you learn? What were today's strengths? What were today's weaknesses?"

Looking Back, Looking Forward

For Jeanette giving up control has transformed her teaching. As she reflected on the changes in her practice, she reported:

"Now I am a facilitator only. The classrooms I have set up in four groups and each group has a purpose. Students walk in and have a list of things they are responsible for—maybe not that day, or next week, maybe in a month. They come in and they're on task...I always say this and it makes people laugh but students no longer sleep in my class and they run to get there. So it makes me feel good when other kids look in the class and say, 'I want to be in your class.' They're running to get there and their projects are out of this world. I wanted to be in charge all of the time and once I let go and let the students take charge, I learned so much. They helped me to learn different things that I wasn't aware of."

Though she stated that in her switch to a "facilitator" she has been enjoying teaching more than ever, Jeanette mentioned that teaching at her school is very difficult. Dealing with some of the parents is the toughest part of the job, she said:

"I think it has to do with the lower socioeconomics. There's not a lot of parental involvement. Sending home homework, you really can't send home homework, because it doesn't get done. There is no one there to say, 'Ok, you have to sit down and do your homework.' So, you have to cover everything in class that you want them to learn, because once they get home, there is no one there to make them do their homework."

The difficulties, she reported, are balanced by the support of the school faculty. She stated that she gets a great deal of support from other teachers and remarked that the staff is highly supportive of one another:

"I feel lucky. Any time I need anything there is always a teacher that's willing to help, or teach me something, or share something that worked for them that may work for me."

Jeanette mentioned a colleague, and former supervising teacher, describing her as the faculty member who gives her the most support and noting that she learned more about teaching in four months from this colleague than she did during her four years of college:

"What they say in the books is not what you have to do in the classroom. [She] just has a way with the kids, and taught me ways to deal with things that would have taken me a long time if I hadn't met her."

Jeanette also noted that, as she went through the ATRL project, she found herself thinking about a science teacher she once had as an elementary student. She remembered loving science "because we did group work." Jeanette said she reflects on this science teacher and how "brave" she was for going against the educational grain of the day and letting students work together. In reflecting on her teacher, Jeanette again remembered how far she herself had come in two years:

"I used to think that people who did group work were asking for trouble, especially here at [this school]."

Jeanette said she finds that her new teaching style has made an impact on her students, many of whom are at-risk not only academically, but also emotionally. Many students, she said, "don't want to be in school. They want to be left alone and are suspicious. They don't want to open up." Though students sometimes resist the sort of sharing and intimacy that is an intrinsic part of good group dynamics, Jeanette noted that the collaborative and cooperative process has resulted in students becoming more articulate about their ideas and feelings. Her students now leave "remembering things, especially social skills."

Jeanette noted that by allowing students to interact more in her class, her discipline problems have actually diminished:

"At first, I was always trying to be in control and I had so many behavior problems. As soon as I became a facilitator, my behavior problems went down by 75 percent. Because I make the students responsible for each other's behavior. And they will. If someone is not working, they'll say. 'Hey, you better work. We're not getting a bad grade because of you.' And it works. They'll listen to each other more than they'll listen to me."

Allowing students to work together in groups, she explained, also allows her to spend more individual time with students who are struggling. "I can spend more one-on-one time with them than I could when I stood there and lectured." The individual attention appears to have helped. Jeanette reported that her students' Louisiana Educational Assessment Program (LEAP), Iowa Test of Basic Skills (ITBS) scores and grades have improved.

Students are not the only beneficiaries of this new system. Jeanette reported that she has changed both professionally and personally:

"I've learned to keep my mouth closed. I always wanted to run the show. Now I've learned to listen and to sit back and let others share."

"Not so long ago I was a very structured teacher. I stood in front of my classroom and my students sat in rows. I modeled whole group practice, independent practice, guided practice and independent practice and that's what we did for two hours every day. And every day I had someone who sat in the back who slept, and I thought, 'Oh well, I'll never reach them.' Now I am a facilitator. I have groups and each group has a purpose. Students know what they are responsible for and they're on task. Students no longer sleep in my class. I wanted to be in charge all the time and once I let go and let the students take charge, I learned so much."

When asked how she envisions herself teaching in the future, Jeanette referred to her goals for her intended practice as her "wow." She admitted that she's not there yet but that every day and every year she gets closer:

"I want to be more student centered. I find I give up a little more every year. Once I see that works, I can let more go. It takes time to get used to it. You just can't jump in and say, 'Okay, now my class is student centered and I'm going to sit here and watch.' It really is a lot of work to have it that way."

"It's easy if I can just stand up there and teach, that's the easy thing to do, because I know everything, I can just spit it out. When you give them control, you have to have structure, everything has to be almost perfect on your part, so that everything will run smoothly, and it takes a lot of work."

"My ultimate goal is to stand around and watch them do awesome things, without the rule sheet—with just a general goal on the board and let them go at it. And I'm getting there. I see that in a couple of years, this will be possible. But it takes letting go and knowing that you can let them on their own and they *will* learn."

Discussion and Conclusions: A "Collaborative Teams" model of a technology assisted constructivist learning environment.

In the span of two years Jeanette has dramatically shifted her teaching practice. She has migrated from being a highly teacher-centered practitioner in whose class both technology and students' voices were absent, to a very student-centered educator for whom technology is an integral part of her classroom and whose method of instruction and curriculum centers around students' abilities and skills. This transformation is due to large measure to the two years of professional development that Jeanette experienced since it allowed her to experience new types of instructional strategies in a safe, non-threatening, and fun environment. However, other faculty members received the same sort of professional development but did not evince the same degree or kind of change as Jeanette. While Jeanette claims that she never wanted to change, the most - centered environment, she possessed the most important characteristics that ensure change—a strong sense of commitment to and concern about her students.

When Jeanette began the project, classroom observations and self reported data indicated that she was "low" in technology use in her classroom. As she herself mentioned, she would not allow students to use computers for fear of "break(ing) them" and the baseline formal observation noted that all four computers were turned off and were not in use. In addition to being low in technology use, Jeanette was also "low" in terms of constructivist practices. Her classroom was highly centralized with Jeanette controlling all activity and all students doing the same thing at the same time. She did most of the talking in the classroom; students sat silently in rows and their only interaction with the teacher was short, or one-word, responses. Jeanette was the center of activity; the teacher's manual that she cradled in her arms, was the fount of all instruction. Students seemed to be passive observers in the learning process. In spite of this sort of dynamic, it was evident from Jeanette's words and tone of voice that she had a good rapport with students and that she was fond of them.

During year one of the ATRL project, Jeanette's practice began to change. She began to gradually decentralize her practice, allowing students work in groups on some activities. With the success of these activities—both in terms of academics and student behavior—Jeanette began to allow the students more and more autonomy and flexibility in terms of carrying out their work. By mid-year Jeanette had made learning centers a staple of her instruction. Subsequent formal and informal observations revealed that the centralization evidenced during the baseline observation was replaced with a distributed style of learning in which different groups of students were conducting different activities at the same time with technology being infused more and more in each activity. Though she had allowed a more decentralized structure, she sometimes wrestled with how much control to actually cede to students. Oftentimes though her students were collaborating on learning activities they appeared to do so silently.

In her year one observation, Jeanette's classroom was characterized as medium technology and medium constructivism. We'll examine in detail the components of this designation.

Teacher role. Jeanette demonstrated the following characteristics of a constructivist learning environment in working with her students:

Establishes a positive rapport with students
Validates and shows mutual respect for all responses
Facilitates, models and shares social and cognitive skills
Inquires about students' understandings of issues and concepts
Provides multiple ways of learning
Seeks elaboration and exploration of students' understanding
Assesses students in a variety of ways

In this formal classroom observation and in other informal observations throughout year one, Jeanette embarked on the path to becoming a "complete facilitator." She talked much less than she did in year one: addressing the class only when absolutely necessary and actively encouraging students to teach one another ("Who can help Alex with that problem?") She also concentrated her efforts on a small group of students with whom she worked intensively rather than less intensively on the whole class. Finally, though almost silent in their activities, students had a great deal more autonomy in terms of their own learning than was evident during the baseline observation.

Student roles. In this second classroom observation, students were generally on task, though as noted earlier in this report, many students appeared bored and some were evidently not working, as noted by the observer. Yet, compared with the baseline observation where students were generally inactive and passive, students in this year one observation generally appeared engaged and attentive as they worked in their learning centers. Generally students exhibited the following characteristics:

Use a variety of both technology and non-technology materials and tools for learning
Use technology to access material that is otherwise unavailable
Show evidence of understanding ideas and concepts
Act as explorers, problem-solvers or active participants rather than passive observers

Curriculum. While the curriculum (or at least the manner in which it was carried out in the classroom) as observed in the baseline observation appeared very rigid and almost out of the teacher's control—a "one size fits all" approach. During the second observation (year one) the curriculum showed much more flexibility and seemed much more tailored to students' needs. Each group was working on a particular language Arts component: grammar, writing, or reading, for example, and, as opposed to the baseline observation, where it had been absent, technology was a part of the curriculum as students used AR to take tests and MS Word for writing. Thus, the curriculum showed the following characteristics:

Structured around complex or many-faceted themes
Part of a larger instructional activity that leads to multiple opportunities for learning
On-going assessment that is interwoven with student learning
Multiple ways to assess student learning
Opportunities for self-guided exploration

Though not evident during actual classroom observations during year one, through her collaboration with the 7th grade science class on "Biography of a Scientist", Jeanette's class during year one evidenced seminal signs of allowing for interdisciplinary learning.

The classroom. Thus during the first year observation, Jeanette's class was certainly a more energized place than it was during the baseline observation, thus moving from the low technology/low constructivism designation to a medium constructivism/medium technology designation. Students worked together in their learning centers, the computers were on and in use. Only two applications were in use by half the class—Accelerated Reader and Word—hence the medium technology designation Jeanette spent concentrated time with one group and the walls were lined with examples of student work. The class evidenced the following characteristics:

Emphasized the activity of the student rather than the teacher
Multiple activities (e.g., writing, discussion, reading, problem solving)
Activities focused on developing higher order thinking skills
Multiple resources were available for learning
Opportunities were available for peer collaboration
Opportunities were available for cooperative groupings or small group instruction
Students are engaged in different activities at different times

As mentioned previously in this report, Jeanette stated that her goal for year two was to become a "complete facilitator." During year two, she made great progress in achieving that goal. While during year one, she embarked upon a process of creating more student-centered learning environment, namely in the form of learning centers, by year two, she was refining this process.

At the end of the two-year project, Jeanette was regarded as "high" in technology use and "high" in constructivist practice. While the format employed during year one and two observations—learning centers—was identical, Jeanette had seemed to ease up on her control of students (or "micro-management' as she has called it). While many students during the year one observation appeared bored within this model, in the year two observation, all students appeared engaged and on task. This enthusiasm was most evident in the amount of student talk. Students were talking a great deal more than in year one where the classroom was almost silent. During the year two observation, and indeed subsequent observations, the

level of noise was higher, but it was "good" noise. As the SEDL observer listened to each group, it was evident that students were talking about the task at hand.

Teacher role. In her year two classroom observation, Jeanette demonstrated the following characteristics of a constructivist learning environment in working with her students:

Establishes a positive rapport with students
Acts as a facilitator—as a guide on the side
Elicits students' prior knowledge
Validates and shows mutual respect for all responses
Facilitates, models and shares social and cognitive skills
Inquires about students' understandings of issues and concepts
Provides multiple ways of learning
Asks open-ended questions requiring multiple answers and development of multiple levels of thinking
Seeks elaboration and exploration of students' understanding
Assesses students in a variety of ways

Also noted during this formal observation was that Jeanette never addressed the class as a whole. Indeed, SEDL staff noted that they barely heard her speak at all. Jeanette did circulate throughout the class from group-to-group, mainly listening and observing and only speaking when students asked her a question. Also noted was that she deflected the question back to students before answering. It appeared that by year two, Jeanette's centers had become routinized and functioned with very little maintenance from her and that both she and her students were much more comfortable with the higher level of student autonomy.

Student roles. In this second classroom observation, students were generally animated and excited about their various activities—grammar, poetry, writing, etc.—and worked collaboratively on projects that were due at some designated times. Students clustered around the computer using Accelerated Reader, MS Word, PowerPoint and the Internet. All computers were in use and small groups worked together at the computer, frequently rotating so that everyone had a chance to produce a part of their product. Generally, in this year two observation, students exhibited the following characteristics:

Interject personal experiences and understanding
Draw upon previous knowledge / experiences to contribute to the learning activity
Use a variety of both technology and non-technology materials and tools for learning
Construct new meaning from the task at hand
Raises questions for exploration or identifies the problem to be solved
Use technology to access material that is otherwise unavailable
Show evidence of understanding ideas and concepts

Act as explorers, problem-solvers or active participants rather than passive observers
Designs methods for answering questions or solving their own problems
Participates in establishing criteria for success/assessment

Curriculum. As in year one, the curriculum appeared to be more flexible and tailored to students' needs. Indeed, in interviews, Jeanette mentioned that she creates activities that are linked to state content standards but beyond that attempts to individualize the curriculum as much as possible to capitalize on students' strengths. Students worked on various Language Arts components—a reading activity with discussion questions, grammar activities, writing, and research— at their own pace and chose the best manner in which to present their work.

Problems are meaningful and relevant to students
Structured around complex or many-faceted themes
Part of a larger instructional activity that leads to multiple opportunities for learning
Provides opportunity for interdisciplinary learning
On-going assessment that is interwoven with student learning
Stimulates thought and action through interesting, relevant and authentic problems
Multiple ways to assess student learning
Opportunities for self-guided exploration

Jeanette has shown greater creativity in the ways curriculum is constructed in her classroom. In one mythology activity, she constructed a story board with candy bars serving as visual cues for parts of the story (For example, "Mars" fought with Mercury…He "Snickers" at that statement…). She read the story aloud to a group of students and had them retell the story in their own words. Students commented that the candy bars helped them remember parts of the story they might have forgotten otherwise.

During year two, Jeanette seemed to incorporate more reflection into her practice, ending each day's activity with such prompts as, "Tell me something you learned today", "What did you like about the day's activities?" and "How can we make these better?" Students seem comfortable sharing their reflections with her and with the class.

The classroom. As in year one, Jeanette's classroom in year two seemed to be a more energized place, only more so. Both Jeanette and her students seemed to feel more comfortable with the high level of student talk and activity. As mentioned previously the classroom was given the designation "high constructivism / high technology" because students were actively, autonomously and independently using a variety of technological and non-technological tools and resources in their learning. In terms of talk, action, and

the locus of learning, the class was truly student-centered. The class evidenced the following characteristics:

Emphasized the activity of the student rather than the teacher
Multiple activities (e.g., writing, discussion, reading, problem solving)
Activities focused on developing higher order thinking skills
Multiple resources were available for learning
Opportunities were available for peer collaboration
Opportunities were available for cooperative groupings or small group instruction
Students are engaged in different activities at different times

The following paragraphs discuss Jeanette's instructional practice in terms of specific elements of technology-assisted constructivist learning environments. These elements were identified from the research literature and were incorporated into the observation protocol used by ATRL staff in collecting classroom data.

School context. Observations, interviews, and results from the *Teaching, Learning, and Computing Survey* indicate that the following school characteristics played a role in Jeanette's development of a technology-assisted learning environment:

Administrative support . During year one of the project, the administrators were very supportive of the changes taking place in Jeanette's classroom. Indeed, Jeanette has mentioned that her principal, "made her" join the ATRL project, as he did many of her colleagues. For the principal, especially, the changes wrought as a result of the ATRL project were very welcome since his district was pushing teachers to become more student-centered and integrate technology in their classrooms.

This principal retired after the first year of the project and was replaced by a principal who was not familiar with either the ATRL project or with student-centered practices. Nonetheless, though Jeanette mentioned that it was sometimes hard for him to support such a substantial change in her instructional practice, he was generally supportive. Jeanette empathized with principals who have a "hard time" when they see students talking and moving about. For administrators such a classroom is a paradigm shift of which they are suspicious, surmising that students are socializing at the expense of learning. Jeanette said she often ended up explaining to them that learning is indeed occurring in this less regimented environment:

"I have to say that when I first started doing groups and the principal would walk in, I could see in their face, they're like, 'Oh, my God, what is going on in here?' The noise level, the students...but once I took them around and showed them, this group is doing this and this group is doing this, and kind of get them involved, they used to just sit there and write. But if I pull them in and show

them what the groups are doing and the kids start explaining, there's nothing but, 'Wow, this is wonderful, this is really great, what's going on.'"

Professional development . The ATRL project provided for 72 hours of professional development over two years. Jeanette attended 60 of the 72 hours and proved herself eager to apply what she had learned. The professional development at her school appeared to make an already close faculty much closer and teachers began to collaborate both in terms of technology use and instruction in ways they had never done before. For example, Jeanette and a number of her colleagues, expanded upon the learning centers idea, creating multiple learning centers across several classrooms. Further, they often traded planning periods, so for example, if Jeanette needed eight (versus four) computers for an activity, her colleague across the hall would give up her planning period to sit with Jeanette's students as they used this teachers' computers. Jeanette would then do the same for this teacher. Finally, in SEDL staff development sessions, as teachers shared activities they had done with students, others would ask if they could collaborate or if they could collaborate across subject areas. In essence, as teachers became "communities of learners", they allowed their students to also become communities of learners. This seemed to deepen the learning experience for all involved.

Jeanette was also exposed to different types of technologies in the Louisiana INTECH training in which she participated in the summer of 1999. This combined with the SEDL professional development, made her more aware of and confident about using different types of technologies and exposed her to more management strategies and instructional practices which she then employed in her classroom.

Technical support. During the two years of the ATRL project, Jeanette and her colleagues benefited from having immediate on-site technical support. One of Jeanette's colleagues functioned as the school's informal technology support person and put himself on call for teachers at all times. Thus when Jeanette's computer crashed, she had technical support within minutes. Consequently, she has enjoyed very good tech support and her equipment has functioned well. Further, Jeanette exhibits a relaxed attitude about technology: as a tool that may break down frequently but that can be fixed fairly quickly. Therefore, technology—and its breakdowns—are not mysterious or insurmountable. She is able to take such glitches as a matter of course.

Technology access. Jeanette describes her school and her classroom as "technology rich" and indeed, compared to other ATRL project site schools, it is. The majority of teachers, including Jeanette, have four networked computers, a color printer, scanner, and TV/VCR in their classrooms. The school also has a number of digital cameras, DVD players, and a satellite system that captures and downloads satellite programming. In addition to the Internet and Microsoft Office suite, Jeanette has very up-to-date software and a host of technologies, such as KidPix, TimeLiner, HyperStudio, and PressWriter that allow students to

creatively express themselves. The variety of technologies may also hedge against boredom on the part of students.

Pressure from external testing. The Louisiana Educational Assessment Program (LEAP) exerts great pressure on teachers in the core areas of Language Arts and math. The LEAP is given at the end of 4th and 8th grade and teachers feel enormous pressure to have their students do well. Lafitte Middle School is a "non-attainment" or at-risk school because its students have scored in the District's bottom 20 percent of LEAP scores. Language Arts and math teachers at Lafitte meet monthly with a District Assessment Team (DAT) that works with teachers to help them improve students' test scores.

Though only Jeanette's 8th graders are affected by the LEAP, the influence of the LEAP is felt in all of her classes. The LEAP is based on Louisiana content standards and in creating curriculum and planning activities Jeanette automatically takes into account content standards. The LEAP is Jeanette's reality and she focuses on it in all grades—6th, 7th and 8th. Where she differs with many of her colleagues is in how she approaches preparing her students for the LEAP. She does not focus on drill-and-practice work to help students memorize previous LEAP test content. Rather she focuses on cultivating higher order thinking skills such as analysis and synthesis of differing points of view and creative self-expression so that students have the skills to tackle a variety of content questions. Jeanette believes that if students are taught proper skills then they can master any content. Many of her colleagues believe students will have an easier time of the test if they memorize information from previous LEAP tests. Louisiana's content standards are very student-centered so there is some dovetailing with Jeanette's approach.

Personal characteristics of the teacher. Jeanette appears to be quite pragmatic and non-ideological. While other teachers have an ideology that defines how they teach and may serve as a fig leaf behind which inaction is defended, Jeanette appears to embrace whatever works. As mentioned earlier in this case study, she embraced student-centered approaches because she saw tangible academic and emotional success with students. This success had a snowball effect prompting her to make further changes commensurate with students' academic and behavioral improvement. Interestingly though, her non-ideological approach has resulted in her embrace of a popular educational ideology: she is a big proponent of student-centered approaches and speaks with a convert's zeal on this subject.

Expectations. Unlike some of her colleagues, who believe that the students' poverty or family situations hamstring the child's ability to learn, Jeanette noted that she has high expectations for her students:

"They are capable of doing whatever they want. With the exception of very few, most of them if they put their mind to it, they can do it. I have a few who don't really have the capability, you know, really low-grade level wise—maybe third

grade and those are hard to work with, but they want to learn. Most of my students, the majority of my students, are very capable on grade level."

Appendix 4

New Mexico Case Study: Kay

A "Learner-Focused" model
of a technology assisted constructivist learning environment.

In Kay's case, she reports that understanding her students and their individual learning styles is the heart of her instructional strategy and the key to success in her classroom. Kay also uses her understanding of multiple intelligences to design multiple modes of instruction. Her lesson plans show that she included opportunities for students to use art, music, drama, and other hands-on activities to supplement reading and writing activities. Once she becomes familiar with a variety of computer software applications and their use in the classroom, Kay begins designing activities so that students can express ideas and experiences through computer technology. While content is important, knowing about her students is her primary consideration. Classroom management, i.e., determining how the computers will be used and other resources allocated and how activities will be carried out, was also based on her students' needs.

Community Context

This case study is set in a rural community located in a river valley in south central New Mexico. The river, forming the border between the U.S. and Mexico, traverses the valley and is the primary source of water for the area's agricultural interests. A mountain range and an interstate highway form the eastern boundary of the valley with the Chihuahuan desert wilderness stretching to the west. Except for the lush green vegetation from the crops growing along the river, the landscape is mostly rocky terrain with minimal vegetation. Frequently, in early spring, before crops are planted, high winds blow from the desert picking up loose soil from the fields and creating dust storms so thick the sun can't be seen even at midday.

Several small towns make up this rural community whose economy and lifestyle are shaped primarily by its agricultural and dominant Hispanic heritage. Most of the population lives along the river valley where chile peppers, cotton, and pecans grow, crops that still must be picked by hand. Migrant workers, following the harvests, move in and out of the area. However, many families have lived in the area for several generations, some establishing successful businesses. Spanish remains the dominant spoken language.

Over 75 percent of residents fall into low income or poverty levels. Most families live in mobile homes or other modest dwellings. The men primarily work in the fields while women often supplement the family income by preparing and selling traditional foods to restaurants, schools, or grocery stores. Older children in the family are expected to share in household duties and take care of their younger siblings after school hours or on weekends. Food is the lifeline of the community. Large gatherings and events bring families and friends together to eat, socialize and celebrate. Weddings, baptisms, funerals, and religious holidays are extremely important. The Catholic faith is usually at

the heart of these celebrations. La Quinceañera, celebrated for a young woman when she turns fifteen and marks her entrance to womanhood, is a major event.

District and School Overview

The school district serves eleven small communities. The district is the single largest employer within the area, employing about 1,500 people. The district has the lowest bonding capacity per student and the highest tax rate among the largest districts in the state, with the present bonding at 100 percent capacity.

According to 1998-1999 Quality Education Data, approximately 12,500 students are enrolled in the district's two high schools, three middle schools, and twelve elementary schools. This district is the state's fifth largest with a student population that is over 90 percent Hispanic. At least a third of those students are Spanish language dominant when they enroll. Seventy-eight percent of families fall into low income or poverty levels, and every school in the district has a Title I designation. Approximately 98 percent of students ride to school on buses.

School site. The site school is one of three middle schools, with a student population of approximately 970 students in grades seven and eight. Statistics regarding student ethnicity and income levels parallel those for the district as a whole. The principal reports that, overall, students' academic performance is very low and that the dropout rate is extremely high after the eighth grade.

The middle school draws students from six feeder schools and along with that comes neighborhood and community "rivalries." Gang violence has been a major problem. Reducing gang violence and increasing parent participation in school activities are two major goals of the school. With a great deal of effort from the principal and the teachers, the presence of gangs in the school has been significantly reduced but parent involvement is still less than what administrators desire.

Many homes are monolingual; that is, parents speak Spanish while their children speak English only in school. Additionally, most parents have had very limited formal educational experiences. These two factors seem to contribute to low participation in activities that the school sponsors for parents and the community. Kay, the subject of this case study, offered her sense of the situation:

> "They're scared because so many of them dropped out themselves. They don't want to feel inferior or basically stupid and perhaps they feel like they can't communicate. So they don't come in. I think they may feel inferior to the teachers."

Technology resources. For the baseline year (1997-1998), Quality Education Data ranked the site school as "medium" in technology. However, during baseline observations most of the school's computer technology was found to be dated and not in general use, especially in individual classrooms. During the baseline year three computers in the library were wired for the Internet but were not connected. During year one of the ATRL project (1998-1999), all the district's libraries were connected with a T1 line, and the site school library became the primary source for connectivity to the

World Wide Web. Students who want to use the Internet are required to have written permission from a parent or adult family member.

Introduction to the Case Study Teacher - Kay

Personal background. Kay was born and raised in the community where she teaches, and is familiar and comfortable with the local culture. Her own family has been in the community for over 70 years. Her grandmother was from Spain but grew up near the U.S. - Mexico border. Kay's familiarity with the community helps her understand her students and infuses compassion in her teaching. In fact, she feels that this compassion and understanding are her strongest attributes:

> "I am more patient and accept the students for what they are, who they are, and where they come from. This is a very unique group of students. We are not upper middle class in a rich district, and I think that when an individual comes to our district they need to be aware of how our children live, and if they accept that they will know how to meet their needs. I feel that I am compassionate to that, because I am a Valley person, I have been here for many, many years."

Motivation, philosophy, and experience. Kay was encouraged to become a teacher by student teachers during her high school years. She went on to earn an education degree and then taught home economics for two years. She described her early teaching style as very rigid:

> "That's how we were taught years ago in the sixties. You follow this path, you follow the curriculum and you don't deviate. I think it's the way I was trained and the way my teachers in high school and elementary were trained. And that's the way I developed my teaching style."

After two years, Kay took a twelve-year "vacation" to raise her family. When she returned to teaching fourteen years ago, she found that she had changed, students had changed, and the school had changed:

> "I was bothered by how much the school environment had changed over twelve years. It was a shock to me. It really was."

Managing the students was the most difficult adjustment for Kay when she returned to the classroom. She vividly recalled that time:

> "We always have had a bad name here at this middle school. And I think it's something that's going to carry on with us forever. The violence! The gangs! All of it! It was very nasty when I first started here. Really, really, bad. I didn't realize there was so much violence . . . and that explains their mode of dress. The curriculum was VERY, VERY structured. I think the attitude of the students and their respectability had gone down. I was more in shock about that. It was very difficult that year. I would leave crying many times. Some one said: 'Be the boss, but be nice.' And that is the best advice anyone could have given me. . . it

worked. You are the boss, but you are nice about it. I have learned over the years to be firm, but yet to be nice."

Kay expressed concern that most of her students will never leave the local area to seek opportunities or continue their education in larger communities close by. She spoke enthusiastically about a new community center, sponsored by the state, which is trying to help students and parents get more involved with learning. It has basketball, a reading room, a game room, and volunteers to help the students continue learning throughout the summer and after school. Kay described it as "the biggest asset that we have ever had."

She also talked about a community organization for women, started recently by the school's female PE teacher. Over a hundred women are coming to the monthly meetings. The organization teaches the women how to read and how to feel comfortable with their child's academic success. The concept is that if the parents feel comfortable, then the students will feel comfortable. Kay said, "A lot of them want to learn, but they say their child gets exasperated because they don't learn English fast enough. We have to say 'Students, this is the way you were at one time, so help mom and dad." She believes that the project is helping because more parents are coming to the school for open houses and meetings.

Kay recalled that when she returned to teaching, the curriculum was still very limited and rigid. Under these circumstances, it was difficult to make learning interesting and relevant to the students. With little opportunity for input, many teachers found limited professional satisfaction in their teaching. However, over several years, the school district introduced a curriculum alignment process. Classroom standards, developed in part from classroom teachers' recommendations, are now aligned with district standards. District assessment periods and assessment criteria are broadly stated; teachers are allowed to make decisions on how they teach in their classrooms.

To meet the challenge of this opportunity to teach her own way, Kay signed up in 1991 to participate in a four-year program sponsored by the Rockefeller Foundation. This program called for a restructuring in the middle/junior high school and a movement away from a traditional teacher-led classroom model of instruction. Kay recalled that many of the activities in this program promoted teaming, collaborating with peers and utilizing resources outside of the classroom:

"That experience directed me to be less 'traditional' and to start working with others. I found more resources. . . so that I could branch out."

In assessing her teaching philosophy, Kay remembered when she was a student in high school, taking a sewing class in home economics:

" It is strange that I mention this but in home economics we had to make the same thing year after year. After four years I was capable of doing advanced sewing. . . but was told I could not. I think at that point, I told myself I would not hold back an individual. You know their learning styles are different and they can do more. I guess that's where I started. . . and I carried on from there. . . I

believe that all students can learn and teachers can teach all learners. Students just aren't all alike."

Baseline Information

Classroom assignment. When the ATRL project began, Kay was teaching in a language art reading lab. Students who are identified as low performers in their reading and writing skills came to her classroom for language arts where they received more individualized instruction. These special classes usually had ten to twelve students per period, about two-thirds the size of the normal classroom in this middle school. The classroom had twelve networked computers that students could use for improving their reading skills. These computers were pre-1997 PCs with no multimedia capabilities, funded from Title I money and with different levels of reading programs. There also were various levels of print reading materials and audio-tapes students could use for improving reading skills. Kay had no experience with computers in the classroom prior to the time she started in the reading lab. She described her early experience:

> "When I came into this program thirteen years ago we had a setup of 12 units and it was 'Here they are. Turn them on and go for it.' A reading program was already installed on the computers and I had very little training on how to use it, so it was trial and error."

Kay noted that at that time, the school provided minimal onsite support for trouble shooting problems with the hardware, the network, or the software for the computers in her room.

Project participation. Kay was invited to participate in the ATRL project by her principal. Even though she was one of the few teachers in the building with computers in her classroom, Kay lacked confidence with her own computer skills. She reported that she was pleased to be asked but evaluated her initial computer skills as "low to medium." She was familiar and comfortable with word processing and sending and receiving e-mail. However, she had few or no skills in spreadsheet, data base, and graphic applications or use of digital cameras. After the first ATRL staff development session, Kay wrote some technology goals for herself with the project. She wanted to "take a chance and experiment with programs" both for herself and for her students and to "become familiar and more at ease" with the technology.

Initial observation. The first formal observation of Kay's classroom was conducted early in the fall soon after the ATRL program began. Eleven students were sitting at round tables working on individualized reading assignments, assisted by Kay when necessary. Students had access to various levels of print reading materials as well as audio-tapes that supplemented the print material. One student listened to audiotapes, another completed a worksheet, several other students read material appropriate to their reading level. The room was very quiet with little or no interaction between students. The students did not use the computers during this observation. Kay explained later that the networked computers had not been working since the previous spring semester. She expressed frustration, deciding that her work request had been forgotten since the computers didn't get fixed over the summer months.

While it was difficult to get a sense of Kay's classroom management skills and her teaching style with this single observation, a review of her initial lesson plans shows that she introduced new lessons with music or by some other non-traditional way. For example, to help students learn how to create more and varied adjectives, she took them to sit in the school's courtyard, near a statue of their school mascot, a Panther cub. She then asked them to describe the Panther cub from where they were sitting in relationship to the statue. Students created a list of adjectives that they could not have generated if they had stayed in the classroom. Kay also used a simple game to get students involved in learning pronouns.

Kay's lesson plans revealed that she consistently used several ways to get students involved in the activity at hand, tapping into their previous knowledge and experiences. Drawing on her understanding of multiple intelligences, Kay said she also tried to tap into their creative minds by trying to identify their best areas and styles of learning.

Based on an initial formal observation, analysis of her lesson plans, and informal observations and conversations, ATRL staff characterized Kay as "moderate" in constructivist teaching practice and "low" in computer use.

The First Year

Early experiences and perceptions. Early ATRL staff development sessions modeled several classroom strategies for creating more student-centered learning activities and collaborative group projects. However, Kay admitted that changing her teaching was not easy for her:

"My tolerance for noise is my biggest downfall. I do try a lot of collaborative learning, but being very traditional, the noise level has been a problem for me, but I am working on it because I do that know that students need peer interaction."

During an interview three months into the first year of the ATRL project, Kay expressed some thoughts about herself and her students:

"My students are very dependent on me. They want me to supply them with the answers. At the end of these two years, I want them to be very, very much in control of their learning, and I want them to become independent thinkers. I will need to change drastically. If I want my students to become risk takers, I have to become one myself. I am growing with the students. They help me a lot. Some of them grab on to it, hold on to it. They are teaching me. It will help them immensely with their creative and critical thinking."

Kay was introduced to *Inspiration* software in the fourth professional development session. This introduction gave her some new ideas for teaching and she immediately wanted to use the application in her classroom. But she had to take care of a few technical problems. First, she only had one computer that would accept the *Inspiration* CD-ROM; the rest of her computers would only accept diskettes. Second, she needed to get her computer network up and running. She quickly enlisted the help of the newly designated onsite tech support person. While these technology problems were being managed, Kay began designing an activity that would allow her students to use

Inspiration. The first consideration was the limited number of computers that would run *Inspiration*. This required her to organize her students into small collaborative groups.

Designing instructional activities. One of the commitments that all ATRL participants made was to create and carry out in their classroom a constructivist learning activity supported by technology. Kay's goal was to create such an activity using *Inspiration* software. She called her activity "Survival." It was based on a novel called *Hatchet* that all of her students were required to read as part of the reading curriculum, a story of the survival of a 13 year old boy lost in the Canadian wilderness. The following brief summary, drawn from her lesson plan, provides a description, goals, and outcomes of the activity:

> "Students work in cooperative groups to create a scenario where they have crash-landed in a remote area. These areas are: wilderness, jungles, desert, or island. Students read the story and identify literary techniques such as motivation and imagery, the use of character, setting, and conflict. Other skills that students are expected to develop are: literary techniques applied to written and oral presentations, cooperative planning, sharing, and learning as well as social interaction and peer guidance, and the use of technology."

Kay's lesson plan described in detail how she carried out the different parts of this activity:

> *Engagement phase:* Students were placed in four groups and drew their settings for survival: Wilderness, Jungle, Desert, and Island. At this point they casually and freely talked about what it would like to be stranded - with no outside human interaction. As facilitator, I listened to each group to monitor who, what, where, when, why and how.
>
> *Exploration phase:* After choosing cooperative roles, students then brainstormed in a webbing fashion their survival scenario. They were given the opportunity to browse through the *Inspiration* handbook to pre-choose symbols for categories. Each group was assigned responsibilities for keeping notes, typing, bringing supplies for the presentation.
>
> *Explanation phase:* Creating on computers in groups. (Two units [computers] have the *Inspiration* program). Time-sharing was a valuable commodity, not only for time on, but also who would control the mouse. Communication was crucial. It had to be fair and involve everyone's input. Once their web was complete, students were expected to analyze and evaluate the layout. If reprinting was necessary, they had to wait for a turn to get back on the computer.
>
> *Elaborate:* Plan a visual and oral presentation. Each member was responsible to discuss one crucial element of survival. The *Inspiration* print out must be creatively displayed as a visual learning tool. Groups must explain the purpose of the *Inspiration* program. Presentation time is limited to 10-15 minutes.
>
> *Evaluate:* On going process. Assess group interaction, creativity of web, concept and literary mastery, visual tool, and oral presentation.

Use of tools and resources: Computer, printer, *Inspiration* software application, models, *Hatchet*, film, overhead transparencies, modeling, video tape presentation to be viewed by parents during Open House in March.

Instructional strategy or strategies: This unit encompassed (1) direct learning by teacher guidance through the novel *Hatchet*; (2) project based - students creating visual tools; (3) simulations - students built battery-powered airplanes and helicopters that hovered over projects; (4) problem solving - individuals had to take charge of their own project from planning, constructing, and presenting.

Kay videotaped the final presentations that the students made to each other and played the video for a parents' open house later in the semester. She also presented the video to her colleagues in the final first-year ATRL professional development session. Here are some written comments from her colleagues:

> "This activity allows students to express their own ideas ... Students explored themes beyond what is presented in the novel ... The activity provided opportunities for a variety of learning strategies and skill building ... The use of the video allows the students to feel as though the work is important and of merit."

In addition to designing the classroom activity described above, Kay challenged herself to use new instructional approaches in other classroom activities. She designed goals within a personal portfolio that would be used for her three year performance review:

> "It had to do with technology, because that was my biggest step, I am very naive when it comes to technology. So, my goal was to incorporate as many computer strategies into my lessons as I could. Granted, I think I only did two. I took baby steps, but I was very happy with it. It was either artwork, or inspirational writing, anything to have the students sit down and think about it in different ways."

Another goal in Kay's portfolio was to increase her "wait time" for student responses. Kay felt that addressing this goal has been an important aspect of improving her teaching. She reported:

> "I have became a more patient person, sitting back and letting the students answer for themselves rather than me answer for them. I wait much longer, maybe a minute, for them to respond, to accept their answer."

End of year progress. The second formal observation of Kay's classroom took place late in the spring semester. Kay taught an activity designed to build understanding through listening. This was a teacher-led activity, with the students listening to an audio tape of a book and then responding to questions that Kay asked, such as, "Why do you think that? What do you suppose that? How do you think it will end? Tell me more about. . . Did you notice that. . . ?" While students did not use technology in this activity, they were frequently observed using *Inspiration* to create concept maps of their reading and writing projects during other informal visits.

At the end of the first year, Kay talked about the changes she had tried to make and her fears about learning and using technology:

> "I am not computer literate. It [the SEDL professional development] went very fast and furious at the beginning. We complained a lot, but we helped each other through it. After we found ourselves comfortable doing it, at least with one of the little projects that we learned, I think the pain eased a little bit. I have become more comfortable with technology and still am not completely comfortable with it, but I'm still trying."

Kay noted that she also continues to develop more collaborative group activities, saying that that she is learning to adjust to the noise. She found that if she walks around to see that students are talking about the activity and are "on task," she is more comfortable with their "noise." She has learned that a teacher in such an environment, "can't just sit at her desk when students are doing this [group work]." Kay said that she tries to have a group activity at the end of each unit.

Based on both formal and informal observations and conversations, it appeared that Kay was trying to change some of her teaching strategies by introducing both new concepts and new technology. While she admitted that it has not been easy and she has not accomplished as much as she had hoped, she saw many new opportunities for her students. It appeared that she has made gains in both constructivist practice and technology use, now being characterized as "moderate" in both areas.

The second year

Changing circumstances. At the beginning of the second project year, the reading lab program was discontinued and Kay was assigned to teach Language Arts in a general 7th grade classroom. This new assignment included three "blocks," that is, three 90-minute classes instead of six 45-minute classes. Kay also became a member of an instructional team of five core teachers. These teachers had classrooms in the same wing of the school and shared the same planning period. They maintained the same 150-160 students, handled discipline of the students cooperatively, planned various team activities, and basically created a family unit for the students. An additional asset to the team was that all five of the team members were participants in the ATRL project. As a result, the students on this team were using technology in each of their classes. They were learning not only reading and writing skills, but also how to create web sites, and to use technology for research and in their math classes. "I see these kids reaching very high levels in technology," Kay noted.

Kay had much to say about the team:

> "Last year I wasn't on a team, but most of the ATRL participants were in my wing. So I could run across the hallway and ask for help or see them in the hallway or in the morning and ask 'How do I do this? When do I do this? Or, I could also ask our new staff tech person [Paul]if he could help. This year Paul has a room [computer lab]. It's very open and we can go into his room and have access to more computers."

> "When I was in the [reading] lab on my own, I became very independent. This year I started back with the team, which I really love, but I had to forego my independence a little bit. I have to sometimes remember that I am part of the team. I like the team because I have more support. When you're out there on your own you don't get to socialize, so to speak, or interact as much. I'm glad I'm back with the team. . . When the five of us meet three times a week, we can discuss the issues and bring the child in and help him. I think that being a team has made this 'family' work for the students."

Collaboration with other ATRL participants helped Kay stick with the program and kept her motivated when it became difficult:

> "The ones that knew what they were doing, they really helped us. And there were some that were in the same boat as I was, at the very bottom, and we struggled and struggled, but I didn't give up. I wanted to, but I kept going. Without that support, I don't think I would have done it. Just looking at the different lesson plans that we had to present, working with teams, what knowledge we did have, I think it rounded me out."

In the reading lab, where she taught previously, Kay's students were primarily lower achieving students. However, the students in her new classroom were of various academic levels. This new assignment proved to be a challenge for her, and she had to draw on all of her previous teaching experiences:

> "This year has been a challenge because I have such a wide variety of intellects in one classroom. I don't want them to get bored, but, it has been a challenge this year to meet all levels. My students range from first grade comprehension levels to twelfth grade. I have some that are very challenging, they outsmart the teacher many times, but I feel like I can handle it. I don't show that Johnny is in first grade. I try to intermingle it so that they are all very comfortable with where they are."

Planning for instruction. Kay noted that she has learned to become more flexible in her teaching. While she designs her lessons to align with district standards, she will change directions if the assignment or activity doesn't meet the needs of the students:

> "I know that this is basically off the wall, but when I start a unit and children aren't into it, I change it. I mean I have to. I don't want boredom in my classroom. Way back when I started. . . I would have been very precise and less flexible. . . more 'rote.' You know, 'This is what I do.' Yes, now I am flexible. I can change. And, I don't really get nervous about it."

Kay observed that organizing the physical environment helps her set the stage for the learning and teaching that takes place in her classroom. Establishing an understanding with her students for how the classroom is organized and what is expected of students helps make a semester successful for her:

> "The organization of my room is very important. I like an even flow pattern. I do not sit. I need to continuously walk, don't want to run into things. I like a reading

area; I like a writing area. I need a personal area that belongs to me. I like enough room to write on the board. A student area with all their books when they come in, I like everything for them ready to go. I don't want any excuses why I don't have things. I just like a very warm slow easy moving environment, making it easy for me. It's all ready when school starts and I walk through it. The first couple of weeks are very structured."

At first, Kay had difficulty organizing her students into groups but in the second year, she gained more confidence. She explained that she knows what works best for her. She organizes the students according to the activity or the assignment. She found that they need a balance of both individual and group work:

> "I try to have one collaborative group every two weeks. I had a student teacher last fall and he was very into groups. That helped me see three group activities at a time. Some were very simple and even spur of the moment."

Kay attended a summer writing institute and learned about using multiple intelligences and noted that she now sees the opportunity to draw upon different ways that her students learn:

> "Seeing what the kids can do, that's what motivates me. Like their activity yesterday, I made the comment: 'If something is not working, we're going to stop and move on.' And that's what happened during the novel – they were dying with it. They were getting really tired. And then we tried their artistic talent. Wow! That was neat! I have learned to tap into their artistic talent, their acting, their drama, their writing, their singing, and I think that's another area that has made me realize that, 'Hey, let's move into where these kids are.' They have some knowledge."

Using technology in the classroom. Kay described how her students interact with each other in the classroom and how technology has influenced that interaction:

> "Having just six computers in my room, they have to pair up most of the time. They respect each other. If they have a slight disagreement, they know how to handle it. That's one of the first things I teach: 'If you work in pairs you have to respect everybody's decisions.' They tend to say, 'Okay, let's try it your way, then let's do it my way.' Yesterday when they were doing a group project I didn't really have to tell them, they just automatically said, 'Okay, it's your turn to control the mouse.' I think that because of the hands on, they abide by the rules. I have not had any theft, which is a big problem in some classes. Yes, one day in my lab they stole the mouse pads, but, on the whole, they have respected the units [computers]."

When asked how the use of technology has changed her students' learning, Kay responded:

> "Basically, the students take charge of their own learning style at the computer. Once they understand the criteria for what they are supposed to do, it is just themselves and technology. They really take charge of their own learning and

that's basically the goal. . . to have the student take command and take ownership."

Kay tracked some of her students' progress and compared the results to previous projects that were taught without the benefit of technology. She reported:

> "In the last three months I have noticed a change in my students' academic growth. They like interacting with the computers. They have grown at least a half year to a year in their reading skills."

Kay noted that using technology has impacted students' reading and writing activities outside of the classroom.

> "My student teacher and myself, really pushed the reading and writing during the first semester and surprisingly, this semester, more and more students are getting computers at home. I don't know if it's Christmas presents or what, their technology is really increasing. They are taking a lot of their writing assignments home to use Microsoft Word or whatever program they have there."

The main software applications that Kay's students use are word processing, a graphics illustration program, and *Inspiration*. She explained that the features of these applications allow students to create and edit in ways that were unavailable before:

> "I have *Inspiration*, which is probably one of the best teaching tools I've used so far. My student teacher was a very firm believer in using artwork with their work. He was instrumental in teaching Microsoft Word. I did use the digital camera last year and I will let them use the video camera when we have things on display."

The middle school did not have Internet access installed in teachers' rooms until late in the second project year, and Kay's instructional use of the Internet remained limited:

> "Right now we use the Internet strictly for my e-mail. I do have two students that asked to use it as soon as they're through with all their work, but it's very difficult to monitor. I re-arranged my classroom and this bothers me because I'm still not comfortable with [the arrangement]. But in order to serve Internet and to serve Channel One and to see what the student is on in the Internet, I had to re-arrange and I can't really monitor as closely as we should. If I'm helping a group over here and he's on Internet, it's very difficult. But they do know I come and check. But so far, they have been very respectful with it."

Kay stated that she does plan to use the Internet in the future, starting in the fall class:

> "I have two research units I just didn't get to this year. We do a lot of research with different countries and I think by having the Internet in our room they can get far more newer information than the books I have in my classroom. So, that's a goal for me next year."

Designing instructional activities. The model lesson plan that Kay created for the second project year reflected a design for an academically higher group of students than the previous year, a higher level of learning expectations, more collaborative group work, and more advanced computer work. The activity asked students "to use critical thinking to analyze sensory details from novels read during the semester and to produce creative writings from these readings." Technology to be used included Paint Brush, MS Word, and *Inspiration*. Students were expected to actively participate in class discussions or cooperative groups "to explore the author's ability to enhance one's sensory images to feel the novels come to life." Instructional strategies included:

> "Direct learning from literature components, audio cassettes of stories to grasp meaning of tone and dialect, comprehension of story elements, collaborative groups to write creatively, keeping a novel section in notebooks, responding to art in journals to become more descriptive in writing, response journals related to character actions, and plot diagramming to understand construction of novel which in turn reflects construction of creative writing."

Looking back, looking ahead

Kay indicated that the key factors in helping change her teaching and using technology are:

> ". . .the members of my team. They have provided help with the technology and emotional support. We're a really strong unit. We understand each other. SEDL has been very instrumental in giving me the support that I need. We had in-service days where SEDL was on hand. We have a support staff that will help me with whatever problems I may have. In previous years we have not had that support, and we also need a pat on the shoulder to let us know that we are doing OK."

When asked how the use of technology has changed her teaching practice, Kay responded:

> "With the technology, it has put the students in a different light and it has put my teaching style in a different light. I am learning to let the students take charge and be more independent in their learning. I want them to take charge."

Kay noted that she recognizes many challenges and has set more goals for herself:

> "[One] challenge that I have had so far is having the time to work on the programs that have been offered to us. I do have a unit [computer] at home, and when I tried to work those programs, I needed the support at home. The students here are my biggest challenge. Yesterday, for example, the program that I would like to use, my computer crashed. So having the ability to troubleshoot. . . that's my biggest challenge. Technology still intimidates me."

Kay described what her ideal classroom with technology might look like:

> "I would take my old room [reading lab] and the room I have now because they're back to back and knock out the wall. Then we would have free rein

coming in here doing projects. I just would like having the freedom to have access to working computers all of the time when they need them. I would like little cubbyholes with dividers where it is very quiet. That way, they're not distracting another group. . . a working quietly group over here and the noisemakers over here. That would be wonderful!"

Based on self reports of her previous experiences and the results of the *Teaching, Learning, and Computing* survey, Kay exhibited a general leaning toward constructivist practice. She noted that constructivism and technology go hand in hand:

"I have really learned constructivism through the technology."

Kay stated that she now sees computer technology as a valuable tool in her teaching. One of her concerns, however, was that students were still slow typing on the keyboard:

"[For] a writing teacher, [the computer] is a teaching tool that helps the students learn how to write better. They learn how to correct the grammar and they learn how to use different resources to improve their thinking and writing. With the spell check, they need to know why the semicolon should have been there. So, it's a teaching tool. But the computer isn't doing it; they are actually doing it. And, it makes for a very nice paper to read."

Kay described where she saw herself in two years as a teacher, using technology:

"I can see myself using more technology, being more flexible, being more relaxed with some of the programs. What's nice with the SEDL teachers is that we all have been trained on the same programs [computer applications], like *Inspiration*. This year when the kids came in to my class, the science teachers had already used it. So they knew how to sit down and immediately use it. My instruction time goes so much faster if kids already know how to use the program. I think that would probably be the biggest thing in two years, if the students know how to do it [use the different computer applications]."

Asked what advice she would offer other colleagues, Kay responded:

"Give it a try. Don't say 'I can't do it.' Just keep on every day, every day. Every day brings new challenges for every time I turn these units on. Just go for it. We set these goals for our students and we need to make some for ourselves."

Discussion and Conclusions:
Kay's Classroom as a "Learner-Centered" Environment Assisted by Technology
When Kay began the project, classroom observations and self reported data indicated that she was "low" in technology use in her classroom. Even though there were two high-end computers and 15 networked older computers in her classroom, students were not observed using the computers for their daily work or special project work. Kay reported that, when they were working, the networked computers were used for reading practice. She had not yet learned how to use the high-end computers for personal or classroom use.

Kay was characterized by ATRL staff as "moderate" in constructivist practices at the beginning of the project. The first formal observation showed students working individually at tables with teacher-led assignments and activities. However, Kay was observed working with individual students to create assignments to match their needs, interests, and abilities. She used a variety of reading materials and tools available to her in her reading lab. Students were given a moderate amount of flexibility in carrying out their assignments.

Subsequent formal and informal observations showed Kay moving away from teacher-led activities to more student-led and collaborative learning activities. All of the computers became operational with additional software applications loaded onto the networked computers. Students were observed using the computers for analyzing reading assignments with *Inspiration* software and using word-processing software for writing assignments. By attending the six, six-hour professional development sessions offered by the ATRL project each year, Kay learned how to incorporate computer technology into a variety of classroom activities. While Kay did not regard herself as "experienced" in personal computer skills (even at the end of the second year), she understood the instructional value of computer technology and the importance of her students learning to use it. One remaining missing element was the instructional use of the Internet, due to a lack of online access within her classroom.

At the end of the two-year project, Kay was regarded as "moderate" in technology use and "high" in constructivist practice. The type of technology-assisted constructivist learning environment that Kay exemplifies can be characterized as a "learner-centered" model. This description emerges from analysis of formal and informal classroom observations, interviews and self-reported data over the two-year period of the ATRL project.

"Learner-centered" is a catch-all term frequently used for defining or describing constructivist classrooms. In Kay's case, this term comes into fine focus as she exhibits the attributes that create the model of a "learner-focused" classroom. Kay reported that understanding her students and their individual learning styles is the heart of her instructional strategy and the key to success in her classroom. She also noted that this approach has guided her throughout her teaching career. The ATRL project helped her more fully understand constructivist learning theory and how it is carried out in the classroom. Kay explained that when planning lessons, she started with the students - where they are and what they need. While content is important, knowing about her students was her primary consideration. Classroom management, i.e., determining how the computers will be used and other resources allocated and how activities will be carried out, was also based on her students' needs.

Kay also used her understanding of multiple intelligences to design multiple modes of instruction. Her lesson plans show that she included opportunities for students to use art, music, drama, and other hands-on activities to supplement reading and writing activities. Once she became familiar with a variety of computer software applications and their use in the classroom, Kay began designing activities so that students could express ideas and experiences through computer technology.

The following paragraphs discuss Kay's instructional practice in terms of specific elements of technology-assisted constructivist learning environments. These elements were identified from the research literature and were incorporated into the observation protocol used by ATRL staff in collecting classroom data.

Teacher role. In her year two classroom observation, Kay demonstrated the following characteristics of a constructivist learning environment in working with her students:

- Established a positive rapport with students
- Acted as a facilitator— a guide on the side
- Elicited students' prior knowledge
- Validated and showed mutual respect for all responses
- Inquired about students' understandings of issues and concepts
- Provided multiple ways of learning
- Asked open-ended questions requiring multiple answers and development of multiple levels of thinking
- Sought elaboration and exploration of students' understanding
- Assessed students in a variety of ways

As the project progressed, Kay was observed to be relinquishing control of her students' learning while expanding her role as a facilitator. She was learning to "stand back" and to encourage students' autonomy and initiative for planning, carrying out, and assessing their own learning. Previously, she felt that she needed to be constantly monitoring students and to take charge of all the activities in the classroom. She admitted this was a major change for her, and noted that the results have led to changes in students as well; they are taking more responsibility for their learning. In a facilitator role, Kay was observed eliciting student's prior knowledge and validating and showing respect for their responses. She frequently inquired about their understanding of issues and concepts; she also asked open-ended questions that required multiple answers and that encouraged development of higher order thinking skills.

Student roles. In changing students' roles in her classroom, Kay created a classroom that allowed students to:

- Interject their personal experiences and understanding
- Act as explorers, problem-solvers or active participants rather than passive observers
- Participate in establishing criteria for success/assessment
- Construct new meaning from the task at hand
- Draw upon previous knowledge / experiences to contribute to the learning activity
- Use a variety of both technology and non-technology materials and tools for learning
- Raise questions for exploration or identify the problem to be solved
- Use technology to access material that is otherwise unavailable
- Show evidence of understanding ideas and concepts
- Design methods for answering questions or solving their own problems

The students in Kay's classes were allowed to interject personal experiences and understandings because instructional activities were designed to draw upon their

previous knowledge and experiences. While this was not a new instructional practice for Kay, she began to express a deeper understanding of its importance for creating meaningful learning experiences. For example, the students were asked to share and write about personal experiences and feelings that were similar to the experiences of the boy in the novel *Hatchet*. Other writing assignments were designed to draw upon experiences from the students' home environment. In addition to reading and writing activities, students were asked to interpret experiences and feelings with both technology and non-technology materials for solving their situation in the "Survival" challenge.

With varied activities like these, the students were becoming explorers, problem-solvers and active participants rather than passive observers. Also, students were taking part in assessing the success criteria for these varied activities.

Curriculum. The curriculum in Kay's classes contained several problems that were meaningful and relevant to students. In addition, the curriculum was:

- Structured around complex or many-faceted themes
- Part of a larger instructional activity that led to multiple opportunities for learning
- Provided opportunities for interdisciplinary learning
- On-going assessment that was interwoven with student learning
- Stimulated thought and action through interesting, relevant and authentic problems
- Provided multiple ways to assess student learning
- Provided opportunities for self-guided exploration

For example the activity designed around the novel *Hatchet* was interdisciplinary and provided an opportunity for students to consider situations that might be familiar from their personal lives. Kay designed this activity to be carried out in collaborative groups, with opportunities for self-guided exploration. Kay's second lesson plan was structured around a complex and many faceted theme. This lesson plan asked students "to use critical thinking to analyze sensory details from novels read during the semester and to produce creative writings from these readings."

The classroom. At the end of year two, students in Kay's classroom were more actively, autonomously and independently using a variety of technological and non-technological tools and resources in their learning. The class evidenced the following characteristics:

- Emphasized the activity of the student rather than the teacher
- Multiple activities (e.g., writing, discussion, reading, problem solving)
- Activities focused on developing higher order thinking skills
- Multiple resources were available for learning
- Opportunities were available for peer collaboration
- Opportunities were available for cooperative groupings or small group instruction

Students are engaged in different activities at different timesKay used a variety of instructional strategies in the classroom that emphasized the activity of the student

rather than the activity of the teacher. These include individual journal writing, individualized reading, teacher-student question-and-answer sessions, group discussions, collaborative groups, and paired activities (especially for computer work). These activities focused on the needs of the individual student and promoted skill development and knowledge-creation through problem solving and exploration.

School context. Observations, interviews, and results from the *Teaching, Learning, and Computing Survey* indicate that the following school characteristics played a role in Kay's successful development of a technology-assisted learning environment:

Administrative support - Kay's principal was totally supportive of Kay and all of the teachers participating in the project. In fact, the principal encouraged teachers to learn new ways of teaching and to use technology in new ways. She told the project teachers that she did not want to see anymore "desks in rows" or "teachers talking with students listening."

Professional development - The school district arranged its in-service calendar to allow for six six-hour days of ATRL professional development during the school year. Over two years, this amounted to 36 hours each school year (72 hours total) of professional development for Kay and 24 of her fellow teachers in this middle school. Kay reported that the instruction from the ATRL sessions, along with follow up support and collaboration from peers, helped her to stay focused throughout the duration of the project.

Technical support – Kay also reported that timely, on-site technical support was a success factor for her and her ATRL colleagues. A technical support person, who had previously been a computer lab teacher, was appointed to support the ATRL teachers and their hardware and software needs. He was able to help the teachers with minor or daily problems as well as to coordinate with the district support personnel regarding more major issues. During the second year of the project, he created a resource lab with several computers for teachers' personal use or for large class projects.

Technology access – At the beginning of the project, Kay received two high-end computers as an ATRL participant. She also had 15 older networked computers in her classroom (which were not working at the time) that were used for reading applications as part of the reading lab where she was teaching. During the early part of that semester, the network for the older computers was fixed. During the second year of the project, Kay changed rooms and was assigned to teach in a regular Language Arts classroom. She had to give up the reading lab computers, but kept the two high-end computers and received an additional new computer. She also received three more donated computers that were upgraded by the onsite technical support person. As a result, she had six operating computers in her classroom. The Internet was not connected in her classroom until early in the last semester of the project. Kay felt fortunate with six computers in her classroom. She reported that three of the five teachers on her instructional team also had four to six computers in their classrooms. The other two teachers had only two computers and consequently carried out fewer computer-related activities in their classrooms.

Pressure from external testing- During the second year of the ATRL project, this middle school was designated by the school as "probationary because of academically low performance." Consequently, the math and reading scores of the 8th graders needed to improve at least by three percentage points by the end of the school year. Over the course of the school year, there was increased emphasis on developing test-taking skills. This activity took the form of "Wednesday Wars" where students took practice tests for a statewide standardized test to be given in the spring semester. While this effort disrupted many of the ATRL project teachers, Kay reported that it did not affect her teaching. Most of the students in her class were already performing well above the "at risk" designation.

Conclusion. When Kay began the ATRL project, she was already an experienced teacher regarded highly by her principal and her peers. Kay's journey to create student-centered classrooms supported by technology caused her to leave some old practices and familiar ways behind. At first this was intimidating for her. However, as she gained confidence over the duration of the project, she was able to determine which of her practices to keep and which to discard. Her willingness to change and to keep improving for the sake of her students makes Kay stand out as an exemplary teacher. While she does not regard herself as having mastered either technology or "constructivist" practices, she looks forward to the challenges that lie ahead.

Appendix 5

Oklahoma Case Study: Clay

A "Wishful Thinker" model
of a technology assisted constructivist learning environment

Clay has a lot of good technology-enriched activities that he said he would like to try in his classroom, but he does not make time to plan them or implement them. With his complex teaching load and added responsibilities as coach and bus driver, he admits that he has little time for planning. Clay is constrained by fairly formidable obstacles. He is overworked as a football, track and basketball coach, school bus driver, and teacher with four or more preparations. Additionally, Oklahoma's content standards are not as supportive of student-centered approaches as those in some other states, and the standardized state test, the PASS, is more content-based than skills-based. The PASS assumes tremendous importance in Clay's school; student success on the PASS is the main priority. Further, Clay's principal is suspicious of student-centered practices and favors traditional learning environments and has not made technology integration a priority in his school. Finally, technical support at Clay's school is highly arbitrary and limited.

Community Context

Clay teaches in an economically depressed rural county in eastern Oklahoma that is situated in the foothills of the Ozark Mountains. The main industries of the area are a regional state college and numerous plant nurseries, as well as tourism related to two large recreational lakes. The poverty rate averages approximately 25 percent. The county's depressed economic status has translated into a relatively poor tax base.

According to the 1990 Census, 65 percent of the county's 34,000 residents are white and 33 percent are American Indian, primarily Cherokee. Many of the Native American residents serve on school boards and in city and county government.

District and School Overview

Almost all the schools in the county serve a predominantly American Indian population who seek to preserve their heritage, in spite of the low proportion (three percent) that speak Cherokee as their first language. The proportion of students who are American Indian ranges from a low of 45 percent to a high of 80 percent.

Seventy eight percent of students qualify for free or reduced lunches. In spite of the county's depressed tax base, however, the area's school districts have become skilled in planning for and obtaining federal funds to support educational improvement.

The schools in this county are unique in that each is its own school district; many principals also serve as the superintendent of their school district. The ten elementary schools contain grades K-8 and all feed into one of two high schools in the county.

The dominant ethos appears to be teacher control. Some school principals have expressed reservations about the use of constructivist practices in classrooms, referring to technology and constructivist practices as "extras." One principal noted, for example, "If I give [teachers] more time for collaboration and development, what they will do – they'll use it to do other things so they can go home sooner." Principals and teachers also have expressed concerns about the PASS, which reveals perceptions of accountability in separate domains (math, science, and geography) without any relationship to each other.

School site. The school is located approximately ten miles from a medium sized city in northeastern Oklahoma. The school serves a predominantly rural population and on average, 62 percent of its student body is American Indian. The faculty is predominantly white, though many teachers are American Indian.

The school is a patchwork of architectural styles and building materials, having been assembled and expanded over time. The school is very resource poor as a quick glance into classrooms and around the grounds will reveal. Classrooms are small and cramped. Many teachers have old, nearly non-functioning computers, and several teachers hold down many school support roles.

Technology resources. Each school has at least one networked computer lab consisting of recent models with adequate speed and memory and common software applications for educational use. However, there is uneven distribution of classroom computers. Clay, the case study teacher, has only one computer in his classroom; it was broken for most of the first project year. His school's computer lab is a Mac-based lab with AppleWorks software as well as the Internet, KidPix and HyperStudio. The lab is used for computer lab classes and for teachers who have special projects involving technology. Teachers may "sign out" the lab for use by their class. In all instances, the computer lab teacher must remain with the students.

Introducing the Teacher - Clay

Background. Clay has been teaching off and on for about 15 years. He teaches multiple subjects in the sixth, seventh, and eighth grades, generally having make four to six different class preparations. He also drives a school bus and coaches football, basketball, and track.

Clay was born in the area but moved away for awhile and then returned. He has lived in the community for 30 years and knows most of the people in the community. He is familiar with his students' families and home environment, as he went to school with many of their parents.

Clay explained that he enjoyed and did well in his own schooling experiences:

> "I could have done anything I wanted to do. I thought I wanted to make a difference. I knew I wasn't going to get rich or anything."

Both his mother and father were teachers and he was inspired to become the same. His father was a well-regarded teacher in the community and Clay talked of him with great pride:

> "Everyone who had my dad for a teacher to this day says 'Boy, your dad was the best thing that ever happened to me.' So, that kind of did it and why I decided to try teaching."

Baseline Information

Project participation. Clay was encouraged to join the ATRL project by his principal. During the two years of the project, Clay proved an active and enthusiastic participant, attending almost every ATRL session. It was clear from his conversations that he wished to modify his teaching to allow for both greater technology integration and more student-centered practices. However, he also described the pressures for meeting current district priorities, particularly those for meeting statewide standardized test requirements.

Experience with technology. Clay reported that he was first inspired to use technology after attending a workshop where he saw a teacher using a projector to display a computer screen connected to the Internet. The teacher doing the demonstration said that students did not want to leave the classroom when they were using the computer and projector.

So, Clay's early notion of technology use in the classroom was a computer connected to a projector so that the whole class could see a presentation at the same time. The school purchased the projector for him, but he was not able to use it for three years because he did not have a compatible computer.

Like most teachers in his school, Clay was trained in some of the basics of computer use: keyboarding and using the Computer Assisted Instruction (CAI) programs. At the beginning of the project, he scored an overall "low to none" on the computer skills checklist. He indicated he had "some" word processing skills but indicated he was "experienced" in his WWW skills. He noted that he has one computer in his classroom – and it does not always work – that is connected to a T1 line for the Internet.

Clay reported that his students go to a computer lab to do their work. The lab teacher directs the activities while they are there, since Clay has duties with another class. Clay expressed his frustration about not being able to be in the computer lab with his students:

> "As far as me getting to go in with that class to the computer lab, it's real hard for me to do because while my home room class is in the computer lab, I have the 8th grade class with me. I would like to be in there with them. That way you kind of get a little motivation out of that. You got to stay motivated to motivate the kids and if you were there seeing some of these ideas take shape, then you're motivated too. You have to ask someone else, 'Well, how did they do?' 'Oh, they did great.' That's OK, but I would like to be in there too. Being able to go in there with them to a computer lab would be a learning thing for me as a teacher as well. That's why I would like to be in there."

At the beginning of the project, Clay said he was hopeful that he could use technology in a variety of ways with his lessons:

> "In the future, if I get my technology running right, and I feel comfortable using it, I hope that we will use the textbook as another resource in the room, instead [of] the focal point of the subject. Hopefully, I can use the Internet to glean information from. As a group maybe geography you could go and visit all kinds of different worlds on the Internet."

Instructional practice. Early in the SEDL project, Clay talked about his teaching practice. He was first asked how he organized his classroom:

> "For the first nine weeks, I have the traditional desks, the rows of desks. It helps with discipline that way. When I see that it is getting accomplished, the discipline task, then I group my classroom, my desks in groups of four to five, and we go into a lot of group work."

Clay then described his teaching strategy for his social studies classes:

> "I draw up a question form, and it's my way of getting the information across to them. I pass one out to everybody, and we will go over them one at a time. I'll say 'who knows the answer to number one?' I choose one of them. If it's correct, I'll write it on the board. Then everybody writes in their outline and that's the way we get the information out. Try to get everyone involved. Then when we do that, we go into our projects."

For his math classes, he noted that he uses a similar approach:

> "I basically get their attention with some stunt or something, put something on the board that will catch their attention. Sometimes I do a couple of problems on the board, then they get into it and then let them start working. We get into a little real life math ... such as buying a car and how interest rates work. We even get into discussing the ins and outs, what the salesmen try ... they surprisingly know a lot about it. We talk about buying houses. They have no idea. Mortgages ... just blows their minds."

Initial observation. The first baseline observation occurred in August 1998 and was designated "low constructivism / low technology". In this activity, Clay reviewed a social studies unit with his 15 male students (upper grades are separated by gender). The activity was largely teacher-led. He asked questions, some requiring short, factual answers and others more probing, to determine their level of understanding. Materials were very traditional: a textbook and worksheets and the mode of instruction was highly centralized: the whole class did the same thing at the same time. In spite of a computer in the corner of the classroom, it was not in use (Clay had indicated his unfamiliarity with technology in the computer skills self-assessment). The only evocation of prior knowledge was a reference back to the previous day's classroom activities.

Though the use of constructivist approaches was very limited, Clay demonstrated the characteristics that make him well liked by the school's student population. He showed respect for all student's answers and though the boys sometimes bordered on being rowdy, he was able to gently calm them down and focus them on the activity, about which they appeared enthusiastic and engaged.

Year One

Designing instructional activities. All participants in the ATRL project were asked to design a technology-assisted learning activity and to present the design to the other site participants. While Clay's first year lesson activity included opportunities for using technology for research, the general structure of the lesson plan described a more traditional approach to teaching. Understanding the working of the United States Congress was the theme for this lesson plan. He was designed the activity to be completed in two weeks. Close analysis raises the question as to whether the amount of work described could be accomplished in such a short time. A more realistic timeline seemed to be a six-to-nine-week unit of study.

The activity began with the teacher introducing the material in the textbook, with the students first reading and completing an outline of the textbook material. The teacher then followed up with a whole group discussion of the outline. The quality and completeness of the students' outlines were criteria to be used for grading and testing for understanding of content. The teacher then divided the class into groups and assigned each group a different body of the U.S. Congress to research. Each group was given a set of questions that they had to answer while doing their research. Technology resources such as the Internet were to be used for the research. *Inspiration* software could be used for describing the passage of a bill and *HyperStudio* could be used to create a presentation that told what they learned about their work in the unit.

It appears unlikely that Clay actually carried out this project with his students. As was true of many other ideas he mentioned through the course of the project, this activity appeared never to be completely thought through or implemented.

Technology use. In year one of the project, upon learning how to search on the Internet and create bookmark files, Clay began to compile an on-line textbook of various history resources that he planned on using as an alternative to the textbook. Clay was excited about such an endeavor since he felt students would greatly benefit from these sites, many of them interactive. Shortly after undertaking this project, however, his one computer stopped working and was not repaired during the remainder of the school year. Consequently, Clay had to use the computer lab for his projects. He expressed the desire for a more flexible lab policy:

> "I wish we had an open lab where you can sign up you class when you want. Hopefully that's down the road. We're still trying to talk and convince people. But we can't right now. We're not set up for that ...but we'll figure out something. I would love to go in and have each kid at a computer. Hopefully we'll get to that point."

Clay brought up the issue of having an open computer lab with his principal but was not encouraged that things would change. He explained, "Things stand in the way for having an open computer lab. The school is uncomfortable with having something open. The school feels that there needs to be an organized class in the computer lab." The implications were that, with the kinds of changes Clay requested, the computer lab teacher would have nothing to do, and the lab might sit empty if teachers themselves were to sign up for the lab.

Clay did not have immediate onsite technical support and there seemed to be animosity between him and the district's tech support person. He explained that teachers cannot access their own hard disk and are not allowed to fix or learn how to fix the problem themselves. Clay's feelings were that the technical support person did not want to lose control by letting the teachers know "too much" about the technology themselves.

In spite of his disappointments with access to technology during the first year of the project, Clay noted that he had some ideas for future projects:

> "Like I said just use the textbook as another resource, like an encyclopedia. Do projects, different ideas for geography. Have them make a travel plan to that other country. They have to pick out a motel. They get a budget to stay within so many miles of the airport they have to find a motel that's reasonably priced. There are just all kinds of ideas out there to do with them. That's where I'd like to go."

Another idea was for students to create a "web" using Inspiration software to show what they had learned about the Civil War.

Year Two

In year two, Clay was responsible for six separate class preparations: (1) 7th grade math, (2) 8th grade math, (3) 7th grade PE, (4) 7th grade geography, (5) 8th grade American history and civics, and (6) 6th grade math. This work load greatly constrained his efforts to change his instructional practice.

Organizing for instruction. When Clay described his instructional strategy during the second year of the SEDL project, it appeared that he had moderately changed his instructional practice. However, he still resorted to an instructional approach that is most comfortable for him, one he used before beginning the ATRL project. For the first two or three weeks of school his classrooms were in standard rows with a podium up front by the blackboard. After he got some sense of the personalities of his students, he started placing them in groups for group projects. When he wanted to "get a lot of information out" and he was "running behind," he put them back into rows.

He explained his general approach:

> "I start by giving them the information first with activities following. I find that if you do the fun stuff first, and try to get the information later, they tune you

out. I give them a reward. Around here, they'll do anything for a piece of candy. In 8th grade math, we spend the first twelve weeks of school in the textbook."

Planning and designing instructional activities. With Clay's heavy teaching schedule and other school duties, Clay found little time for planning: "A lot times, I try to plan. But usually it's by the seat of the pants. I usually just kind of go in." During football season, he basically planned day by day. His planning period was right after lunch, when he planned for the afternoon classes and then got an idea for the math classes the following morning. He noted his concern that the students "are kind of cheated," but said, "I can only do so much." After coaching season was over, he tried to plan about a week ahead, but then noted that he rarely followed his written plans. He explained that he tries to remain flexible.

When he did plan, he planned mostly for his 8th grade students because they had to take the PASS test, a series of standardized tests. He concentrated on helping his students on their PASS skills. He reported that in previous years, the 7th graders took the tests, so he planned the most for the 7th grades.

Clay explained that after he finishes work with the PASS booklet, which takes him until about February of the school year, he plans other activities, except in math, in which he uses the textbook throughout the school year. With his 8th grade boys, he says "when we do history, it's war, war, war. We hit just about every war." He "hooks" them by telling them that they must first do the PASS skills and then they can make some choices what topics they might cover in class.

Clay described a unit on the War of 1812 that his students were working on:

> "We're on the War of 1812 right now. We brainstormed. I said, 'somebody give me something you know about the War of 1812.' And they were just firing off ideas to me and I was writing them on the board and circling them and scattering them out. Then what we did after I got all of the information, I had them copy what was on the board. And the assignment as a group was to make what I call a bubble flowchart. I don't know any other way to describe it. You just, as an organizational tool, organize the ideas, into how they perceive the events and occurrences of the war of the people. It's like I told them: 'There's not a wrong way to do it. It's just the way you as a group you perceive these events.' And then as soon as they get their charts done, each group presents it and we have a little question and answer session with them. They need to know why they put this event here and this event there. I am hoping they can see and get a better idea of the time line concept."

The students used no technology for the War of 1812 project. However, Clay was still hoping that he would eventually get his projector to work and that would make the project better the next time.

> "Without the technology ... we kind of had to improvise [the bubble chart]. We did it on the black board and then on poster board. They have the concept. When and if my computer gets up and running, we'll try it on the computer. I

have a projector and I could project my computer up on the screen so the whole class can participate."

Clay expressed the need for having students doing collaborative project work:

> "It's important for kids to work in groups because we live in groups. They have to learn how to get along with each other. They get ideas from each other. I don't have any problem with them helping each other out. I explained to them what help is and doing it for somebody else."

However in practice, Clay found it difficult to use collaborative groups on a regular basis. When reflecting on the War of 1812 collaborative project and planning for the following year, Clay talked how that project took much longer than he expected: "It took as long to do the project as it did to fight the war." Since he got behind in his curriculum, he had to revert to his customary teaching strategy:

> "So, after that, I put them back in rows and really and got after it. I would like to do more but it's kind of hard when you have 25 or 30 13-15 year old boys ... they kind of fill the room up."

Nonetheless Clay did sometimes try to do collaborative projects. In his math classes, Clay had his students research the types of careers they wanted to have as adults and match such career aspirations with lifestyle choices and income. The unit, extremely popular and enlightening for students according to Clay, resulted in students calculating mortgages, car payments, factoring college tuition for spouses, and looking at different types of investments. Students used the Internet to research housing prices, find the best available mortgage rates, and study the risk associated with certain types of investment. Clay also took his students to a car dealership and to a used car lot to look at automobile prices and financing options.

Clay referred to this as the "best" activity he had ever done with students. He reported that for students the activity was illuminating both academically and personally. He mentioned, for example, that the activity forced students to rethink their academic performance ad how it affected both college acceptance and income earning potential. Most important, Clay reported, the activity showed students the importance of numeracy and financial savvy:

> "They all wanted big houses and big cars and weren't going to let their wives work. But then they saw how much everything cost and how much money in taxes they'd have to pay and they had to change everything."

The activity, according to Clay, engendered rich discussions on such topics as the importance of school, the availability of jobs in their region, inflation, and the fairness of taxation, etc.

Using technology in the classroom. In the second year of the project, Clay had a single classroom computer that worked. He described his difficulties in trying to incorporate one computer into his classroom activities:

"I found it really hard with just one computer. I never found a way. I always felt like ... that the kids who wanted to be on that computer were going to be on that computer. And I found that the others were ... 'if not that's fine.' You have two or three sitting at the computer doing something, those two or three are missing out on what you and the rest of the class are doing. I constantly felt like I was backtracking, trying to pick up. Basically what my computer was used for, if we had a question in geography or history that I didn't know the answer to, and they couldn't find the answer anywhere, then we'd get on the Internet, with a kid who wanted to look for it. That's basically all it was used for, I hate to say."

Clay felt that students should spend more time learning how to use computers rather than taking other electives such as chorus:

"You look at all the jobs that are going to be available for these kids. I mean, five or six years from now. It's all going to be technology. Ninety percent of the jobs are going to have something to do with running a computer. My opinion is that they ought to be in that computer lab, rather than singing."

Looking Back, Looking Ahead

When asked to reflect on his instructional beliefs, Clay noted that he uses his coaching background to help form his teaching philosophy and his understanding of constructivist learning theory:

"When you coach, you can demonstrate all you want. You can talk all you want to a kid, but until you let them get out there and throw them the ball and let them do what you're trying to tell, them you're just talking to this wall. I see how it correlates now ... You got to let the kids do it. You can't do it for them. You got to let the kids do it. So that's hopefully what they are meaning by constructivist learning. Constructivism ... teaching constructivist learning ... I'd always heard it explained ... I'm like a dumb old coach. You got to break it down and explain it to me ... You tear something down into its parts, and then you build it back together ... I get that ... have them come up with the information. One of the questions is ... What did we leave out. Did we leave out some significant pieces of this puzzle?"

Clay reflected on his students and their learning:

"Kids that are so used to being spoon-fed everything. 'Show me what to do now. What do I write here? Is this right?' I mean that's the barrier, just breaking that down and getting them to realize, 'Well, I might know something. I might know a little bit about this.' Kids have been taught not to fail. But I think, every once in awhile, a little failure if you take it and turn it around and have them learn why they failed ... maybe use that as a motivational tool for them to do better the next time. I always say, 'Trust yourself. If that's what you think, then go with it. If it's wrong, it's wrong, and we'll figure out why it's wrong.'"

The hardest part of teaching for Clay, he said, is motivating 13 and 14 year old students:

> "I wouldn't say they are not motivated; it's just trying to find what motivates them. It's kind of difficult to find that one little thing that's going to get the kid motivated."

He also noted difficulty in "having to deal with so many different levels in one classroom. I have yet to figure out a way to do that." He explained that, since he doesn't have time to figure it out, he teaches to the middle and upper levels. He noted that math is the most difficult, with students at four to five different grade-level understandings in one classroom. When he does group students, he explained, he mixes the groups with all skill levels. He said he feels some resentment from the more academically able students when he groups them this way, but he tries to make it up to them by giving them some extra attention. However, the less advanced students appear not to try as hard because they know they won't get that extra attention.

Clay repeatedly noted that time is a big issue. Just getting to where he should be in any given day, with so many different classes and other responsibilities, is a daunting task. Clay also remarked that the State Department of Education brings additional requirements to his job:

> "They keep sending stuff that they want the teachers to teach. They just keep piling it on. Paperwork, it's just constant. There just is not enough time. Now they are asking for students to learn a second language ... more Spanish ...or Cherokee."

The easiest and best part of teaching for Clay, he explained, is:

> "... dealing with the kids, when you finally get something across to them and they really catch on. Plus, parents are pretty supportive around here, it's a small area, and I know most of them. I went to school with a lot of them. They are real supportive. "

He said he feels that his effectiveness as a teacher:

> "... probably out of a scale from one to ten, [is] an eight most of the time. Every once in a while you will hit that ten, but overall I would say, seven or eight."

He described his strongest attribute as a teacher:

> "Probably being able to communicate with these age group kids. I feel like they need to know how to learn, not just fill their heads with a bunch of facts. It's like I tell them. 'There is a time when you get to be an adult that you got to know how to learn. There is not going to be someone there to answer a question. You got to know how to find the answer for yourself.' I think communication and maybe just motivating them to want to do something ... that is probably my strongest point."

Clay is constrained by fairly formidable obstacles. He is overworked as a football, track and basketball coach, school bus driver, and teacher with four or more preparations.

Additionally, Oklahoma's content standards are not as supportive of student-centered approaches as those in some other states, and the standardized state test, the PASS, is more content-based than skills-based. The PASS assumes tremendous importance in Clay's school; student success on the PASS is the main priority. Further, Clay's principal is suspicious of student-centered practices and favors traditional learning environments and has not made technology integration a priority in his school. Finally, technical support at Briggs is highly arbitrary and limited. Teachers are not allowed to download software, access non-approved types of software or access certain parts of their computer. More critically, and harmful from a learning perspective, computers break down and remain broken for months.

In spite of such constraints Clay has modified many of the activities he used to do in a traditional manner. For example, rather than using the textbook to teach about Europe, Clay now has his students plan a European tour. Using the Internet, word processing, spreadsheet and electronic presentation software, students are given a certain amount of money to be used to visit as many European countries as possible. They plan their trips in groups, research the best prices for air fare, conduct on-line currency conversions, plan an itinerary, download images of their destinations, and learn a bit of the language in their destination countries. Within each country they must visit a certain number of cities / sites and prepare reports on their travel. Though the activity takes a long time, Clay reports that the students really enjoy the activity, though the same cannot be said for his colleague, the computer lab teacher.

Discussion and Conclusions: A "Wishful Thinker" Model of a Technology-Assisted Constructivist Learning Environment

After the first classroom observation, at the beginning of the ATRL project, Clay was considered to be "low to moderate" in constructivist practice in his classroom. He was observed leading an animated discussion that required several 8th grade teams to create a concept web for analyzing the War of 1812. Student research and analyses of different aspects of the war followed this whole group activity. The students were then allowed to use the computer lab for writing papers and presentations. This initial observation showed Clay's skill for keeping students engaged and interested in a teacher-led activity.

At the beginning of the ATRL project, Clay was regarded as "low" in technology use after the first observation. No students were observed using the one computer in his classroom. He later reported that this computer did not work and he had been waiting for a long time for someone to come and fix it. However, he reported that there was a computer lab that students could use for their projects.

The type of technology-assisted constructivist learning environment that emerged from Clay's classroom after two years of ATRL professional development and support may be described as that of a "Wishful Thinker." While Clay was an enthusiastic and consistent participant in the ATRL staff development sessions, he changed his teaching practice very little. He appeared to remain in the "awareness" stage of the change process. He had many creative ideas for how he could use the different software applications for engaging students in projects in his classroom but did not have adequate time to plan and carry them out as he desired. ATRL staff also noted that the

conversations regarding these activities primarily focused on the technology application and not so much on the instructional strategies required to successfully implement the projects. However, this focus is consistent with responses to the Teaching, Learning, and Computing (TLC) survey, which asks respondents for the three most important objectives of middle school education. Clay listed "developing skills in using computers to analyze and present ideas."

Although Clay tried to make a project interesting and relevant by having his math students plan a European trip, the projects was carried out with mixed results. Clay explained:

> "I gave them an eight thousand dollar budget. It sounded real good to me in my head at the time. But it got to the point where I dreaded it (going to the lab)."

He added that there were unanticipated difficulties with the Internet connection in the lab and some web sites were blocked. Also, he had not taken time to plan how to explain money conversions of the various countries and other similar issues within the project. In general, he had not thought the activity through completely. As he said:

> "I try to come up with stuff. Some of it works, some of it doesn't. Out of thirty students, only three or four students actually finished the project. I didn't have time ... it just kind of faded away."

At the end of the ATRL project, Clay remained "low to moderate" in constructivist practice in his classroom. Both formal and informal observations indicate that Clay's primary teaching strategy remained teacher-centered. While he had lots of ideas for making projects relevant and interesting to the students, carrying out those projects to completion was inconsistent. The final formal classroom observation found Clay standing in front of the class reading back questions from a social studies test in an all boy's 8th grade social studies class. For the most part, students ignored him and the class seemed out of control. Clay did all of the talking and read out all of the answers himself. His answer giving was frequently punctuated by threats and warnings to quiet down.

Still, in this late stage of the project, Clay had one computer in his classroom that didn't work and was not connected to the Internet. Students used computers in the lab but not on a daily basis. Clay's final computer skills checklist indicated that his computer skills had increased primarily in word processing and in "some use" of electronic spreadsheets, HyperStudio, and a digital camera.

Data from informal and formal observations, the computer skills check list, and the Teaching, Learning and Computing survey reveal more details regarding Clay's instructional practices and the use of technology. Analysis of this data also further shows several contradictions between Clay's stated personal views and what he actually carried out in the classroom.

The following paragraphs discuss Clay's instructional practice in terms of specific elements that contribute to or constrain technology-assisted constructivist learning environments. These elements were identified from the research literature and were

incorporated into the observation protocol used by ATRL staff in collecting classroom data.

Teacher role. As indicated in his responses on the TLC survey and informal interviews, Clay saw his role as a facilitator of learning in his classroom in terms of "providing opportunities and resources for my students to discover or construct concepts for themselves" However, observations show that the frequency and quality of this role was inconsistent. For example, Clay's most frequently used strategy, for teaching both the required components for the PAAS test and "optional" course subjects, was preparing an outline of the subject in handout form. He then had the students read from their textbook to complete an outline of the subject. He then conducted a whole class discussion; later small groups were formed to write papers or create presentations, if time and the computer lab were available.

Clay tended to "slightly agree" with the TLC survey item that states, "Instruction should be built around problems with clear, correct answers, and around ideas that students can grasp quickly." Clay also tended to "slightly agree" that "how much students learn depends on how much background knowledge they have – that is why teaching facts is necessary."

Student role. Clay reported that he wants students to develop independence and life skills and become "good people." However, activities or teacher modeling of these skills were not observed in his classroom.

While he also reported on the TLC that "sense making" is more important than "content," Clay was consistently observed teaching content. However, it should be noted that the school district demanded that content must be taught for the PASS test.

Students in Clay's classes were encouraged to participate in activities and discussions but they did not make decisions regarding the activities to be carried out or how they would be assessed. However, Clay reported that in his 8th grade social studies class, he allowed student input for a unit that they would carry out after the PASS preparation was completed. On the TLC survey, Clay indicated that the frequency in which he "lets student interest influence the topics of the lesson" was the "same as before."

Curriculum. The lesson plan that Clay designed and intended to carry out at the end of the first school year was consistent with his description of his teaching and with observations of his classroom. While the lesson activity included opportunities for using technology for research, the general structure of the lesson plan described a more traditional approach to teaching. Understanding the working of the United States Congress was the theme for this lesson plan. The activity was designed to be completed in two weeks, although a more realistic timeline seems to be six to nine weeks.

Observations were not made of the activity and Clay did not mention it later in either informal or formal interviews. The conclusion is that Clay did not carry out the project after all. This gives support to the "Wishful Thinker" model of Clay's classroom – thinking about what he would like to do in his classroom but not being able to carry it out.

Clay expressed his goal for students having meaningful and relevant activities – especially in his math classes. He described the "Road Trip" activity where students in his math class used their math skills for planning and budgeting a trip in Europe. He also talked about activities for buying and selling cars and financing a home mortgage.

Classroom. On the one hand, Clay's TLC survey responses stated that open-ended problems are "very useful." On the other hand, his responses indicated that the activities students most frequently carry out in his classroom are "working on their own assignments at their desks ... answering questions in the textbook or worksheets." He also reported that he "plans lessons using the principles of direct instruction (review, tech, guided practice, individual practice)," an approach that is the "same as before" his participation in the ATRL project.

He reported on the TLC survey that he "more now" has students teach or help each other, review their own work, make predictions and investigations, and work in groups. He also reported that he "more now" closely monitors and supervises students while they work."

Clay reported that computers have had a "substantial role" in student assignments and have brought about a "big change" in the way he breaks up class periods into activities, his beliefs about curriculum priorities, and goals in teaching.

School Context. The context of the school environment and Clay's teaching schedule appeared to have an important influence on how Clay carried out instruction. The following characteristics appeared to play a strong role in shaping Clay's instructional practice.

Administrative support. There was little administrative support for implementing constructivist teaching practices. As noted earlier, some principals referred to technology use and constructivist practices in the classroom as "extras."

Technology access. Clay had only one computer in his classroom and the school computer lab policy restricted the ways in which he could access the computer lab for student projects. His students attended computer classes, but they were separate from the content courses. Coordinating with the computer lab teacher for his classroom projects required advance planning, for which Clay rarely had time. The one computer in his classroom was connected to the Internet and was occasionally used for student research.

Technical support. There was a clear lack of timely technical support. Clay's one classroom computer was not repaired for almost an entire school year.

Time constraints. Clay had a lot of apparently good ideas that he said he would like to try in his classroom, but he did not make time to plan them or implement them. With his complex teaching load and added responsibilities as coach and bus driver, he admitted that he plans and teaches "by the seat of his pants."

Pressure from external testing. With a strong emphasis from his school district on passing the state PASS test over any thing else, Clay feels that he cannot afford to change his teaching practice. His strategy is have students work on special projects once he has covered the "required" content for the PASS.

Conclusion. Clay mostly used direct instruction to "get the information out" to the students. He said he can cover more material in a shorter time by doing it this way. While he appeared to begin to grasp the meaning and significance of constructivist teaching practices, data show that he did not make significant changes in his teaching practice to accommodate constructivist practices. When he spoke about the ATRL project's importance for him, he most frequently mentioned new software applications that he learned, not new teaching strategies or changes in instruction to which he also was introduced. He appeared to think of technology as an addition to his "bag of tricks" that he could use to gain and maintain student interest in his class. He admitted that he was looking for ways to "entertain the kids [and] is more into letting the kids have fun."

Appendix 6

Rural Texas Case Study: Martha

A "Learning-Centers" model
of a constructivist learning environment supported by technology

Martha developed learning centers after participating in the ATRL professional development sessions, which modeled that kind of a learning environment. Initially, her centers were a mix of subjects including language arts, social studies, science, art, and health, and always involved the 4 computers as one center. As she reflected upon her teaching, she began to create thematic centers based upon science and social studies units. She arranged her room with four to five centers, where students worked individually to complete activities and gather information about the thematic unit. Students quietly collaborated with each other, with some working on the floor. The 4 computers served as one center and was used for research on the Internet, or the creation of a product in a specific software application.

Community Context

The case study school serves a small community west of El Paso, Texas, along the banks of the Rio Grande River. The Mexican American Legal Defense Fund has identified the town as containing one of the poorest census tracts in Texas. The primarily agricultural community is located near a major interstate highway. Small, locally owned and franchise businesses are clustered on either side of the main road. Plans for widening the interstate are expected to make the region more desirable to developers. The tax base and tax revenues for the district are increasing with new industrial growth in the area.

According to the 1990 Census, the 4,500 member community is comprised mainly of residents of Hispanic origin (83 percent). The remaining 17 percent are white, non-Hispanic residents. Seventy percent of households speak Spanish as their first language. The median household income is approximately $18,000. Fifteen percent of households receive public assistance.

District and School Overview

For many years, schools in this community were part of the El Paso Independent School District. In 1959 the people of the town voted to establish their own school district. Due to its low tax base, the district has the lowest per pupil allocation in its region.

According to the 1998-1999 Quality Educational Data, approximately 4,600 students were enrolled in the district's seven schools, an increase of approximately 700 students within the past four years. The regular high school (grades 9-12) has 1,074 students; the alternative high school has 26 students, and the middle school (grades 7-8) has 611 students. Enrollment in the four elementary schools (grades PK-6) ranges from 567 to 814 students. Hispanic students comprise 91 percent of the district's student population; eight percent are classified as white and one percent as African American.

According to the 1998-1999 Quality Educational Data, 58 percent of the district's students are college-bound. Fifty-three percent of students are classified as at risk and 42 percent are identified as having limited English proficiency. At all campuses, the entire student population qualifies for free and reduced lunch. Each school has been declared a Title I campus by the state education agency.

School site. The site school is an elementary campus serving grades PK- 6. In 1998-99, 94 percent of the school's 814 students were Hispanic; all students were classified as economically disadvantaged and 53 percent as limited English proficient. Dual language education is a major academic focus at the school. The school facility includes both an old building and a new building, which houses the first through third grades, special education classrooms, administrative offices, cafeteria, and library.

Technology resources. The 1997-1998 Quality Education Data ranked the site school as "medium" in technology. The district has a technology department, which includes a lead teacher for technology, and each campus has a full time technology specialist.

The new school building, in which the case study teacher's classroom is located, is completely networked for technology, with four multimedia computers and a printer in each of the 18 new classrooms, and 12 multimedia computers in the library. The computers are networked in an Intranet; Internet access is also available. Primary software applications are Windows '95, Microsoft Internet Explorer, Lotus SmartSuite, and the School Vista management system.

Introducing the Teacher – Martha

Personal background. Martha has been an elementary school teacher at this school for eight years. She taught first grade during her first two years of teaching, and has been a third grade teacher ever since.

When Martha was a child, her mother predicted she would be a teacher. All through Martha's childhood, her mother was a school volunteer who knew her children's teachers. When Martha was in high school, she and her mother met with the high school counselor, who helped guide Martha's low income family through the process of applying for scholarships and grants for college, for Martha to study to be a teacher.

Motivation, philosophy, and experience. Although Martha was a good reader and successful in school, she does not believe the traditional way she was taught is the best way for children to learn:

> "I remember learning just from reading. I had a very good memory, but I didn't like the way school was taught ... Even as an adult I can't sit and listen to someone lecture and learn. I need to be involved. I need to do it along side of the teacher. And I realize that need. So here, I'm teaching to young children and I know they are not going to learn if I'm standing there teaching. I know they need to touch and they need to move and need to share. And they need to talk to other kids about a problem they might be having. ... And I can pace myself according to their needs. I won't go any further unless they have mastered. And they're so willing to let you know because they want more. Or they're so willing to say, 'I

don't understand this.' So I'm aware that I sometimes need to stop and do this again."

Martha reported using very little of the information she learned as an education major in college when she began teaching. She learned her most practical skills for teaching, first through her student teaching and then by collaborating with experienced teachers at the first grade level. When Martha taught first grade, the emphasis was on teaching the students how to read. Martha's classroom, like the other first grade classrooms at her school, had centers. To decrease the planning involved with creating centers, the first grade teachers shared their thematic centers with each other.

After two years of teaching first grade, Martha began to teach third grade, the level at which the Texas Assessment of Academic Skills (TAAS) is first administered in reading and math. The TAAS is a part of the Texas statewide assessment program. It measures student success with the statewide curriculum; satisfactory performance on the exit level tests is prerequisite to a high school diploma.

When Martha recalled moving to third grade, she said:

> "I didn't know how to teach third grade. I thought I had to teach the TAAS, and TAAS was a new thing for me. So, the first year I remember just teaching TAAS objectives ... I don't know how you would do that. It was really difficult ... Third grade teachers helped me teach TAAS objectives, but it wasn't comfortable for me. I wasn't sure of myself. I thought I'd rather teach a lesson, and have the objectives in them, instead of just teaching TAAS."

During her first few years of teaching third grade, Martha reported being a traditional teacher:

> "I didn't work in cooperative groups. We had a traditional classroom with the rows and I taught and that was it. And then inclusion started here [in 1994], where we had to include the resource kids. They were in the classroom, whereas before they were pulled out. So, when I started teaching inclusion students, I had to put them in groups, and that's when it changed."

Inclusion students include those with speech or language impairments, mental retardation, serious emotional disturbances, hearing, orthopedic, or visual impairments, or other health conditions, in addition to students who are two years below grade level in achievement. When Martha began integrating inclusion students into her third grade classroom, she began to change her teaching practice to a student-centered classroom. She reported that this occurred primarily in her language arts instruction, where she began to use cooperative groups for reading and writing.

Experience with technology. In 1994, the school district residents approved a $10 million bond issue. A portion of those funds were allocated for construction of a new building for the elementary school. With the construction of the new building came new access to computers in the classroom, and teachers needed to learn how to use those computers. Martha's initial reaction to the four computers in her classroom was:

"Oh no, what are we going to do with four computers, I don't need them! Then I thought, well, four computers for AR [Accelerated Reader] will be good."

Martha had had one computer in her classroom for a few years, but she only used it for the Accelerated Reader program, and an occasional lesson that the computer teacher taught in Martha's classroom. Accelerated Reader is a computerized learning information system whose goal is to help teachers motivate, monitor, and guide critical reading practice. Students take computerized tests after reading a literature book from a large group of selected titles. The Accelerated Reader software tracks student scores and records, giving teachers, parents and administrators an overview of progress by individual, class, grade and school. This program includes a schoolwide reward system for quantity of books read and for moving to higher reading levels. The school began working with Accelerated Reader in 1996 and became the nation's first bilingual Reading Renaissance Model School in 1997. Students are able to read selected books in English or Spanish, and take a computerized test in either English or Spanish.

In addition to using the computer in the classroom for Accelerated Reader, Martha's third grade students visited the computer laboratory once per week for a lesson by the computer teacher.

"We would go the lab once a week, but I was mostly a helper. Where [the computer teacher] would set up the lab, the computers were on and any trouble we would have, she would take care of them. I never touched the computer. I walked around and watched the kids. So, I was never involved. I saw a lot of drill work that we were doing in the classroom on paper. And I really wasn't too thrilled about what was in the lab ... The kids loved it because it was different. There were pictures for them to see. But, it was very controlled ... They learned basic computer skills, keyboarding. But it wasn't something they could be very creative with. They weren't on their own. They all did one lesson and many times they wouldn't finish that one lesson ... I didn't see any gain in that. But, we would go every week."

Baseline Information

Project participation. The school did not have a professional development plan, to help the teachers learn to use the new computers and software in their classrooms. When SEDL proposed working with the school, the principal was happy to have a training process which suited the goals of the school. Each of the 25 teachers signed a letter of commitment to work with SEDL . Martha said:

"We only had one [computer] in our classroom. And then last year, when we started with SEDL with the four computers ... it was like 'WOW.' It was overwhelming. It was overwhelming because I didn't know anything about computers. And I thought, 'Okay, well, I'm hoping' ... The fact that I wasn't going to be just by myself. If we were a group ... we knew we would be trained, and it would be nice and slow."

Initial technology skills. On her initial technology skills self assessment for SEDL, completed in the spring, before the professional development began that summer, Martha marked herself as experienced in only four skills out of 86: turn the computer

on/off; turn the monitor on/off; use the mouse; and print documents. She ranked herself as having "some experience" in six other skills, leaving herself with a self-assessment of "no experience" in 76 skills. She had never used word processing software, let alone a spreadsheet, a database, a browser or email on the Internet. Martha was very unsure of her capabilities when she began the SEDL training:

> "And then when the SEDL program began, I thought, 'Okay, there is more out there.' So I was excited about it. But, I was still very apprehensive. I wasn't sure if I could teach the kids if I didn't know myself how to use it."

Initial observation. During a formal classroom observation in the fall of the first year of the project, Martha's four computers were not used by the students. The four computers and the printer were in the corner of the classroom, asleep. Martha was conducting a math lesson to nineteen students, and all the desks and chairs were in three rows, facing the front of the classroom, where she stood. All of the students were doing one math activity, led by the teacher. The lesson was about rounding numbers with students locating the number on the number line. Students had a handout of a roller coaster with numbers on it, to represent the number line. They also had hippo manipulatives, which they placed on the roller coaster.

Martha conducted a standard lesson with direct instruction, guided practice, and independent practice. After the teacher explained a problem, she asked if the students understood. Some said yes and some said no. They did another problem as a whole group. The teacher called on a quiet student to respond, and when the child hesitated, Martha said, "You're right. You want to say it." The student quietly said, "840." Martha said to the class, "Is she right?" "Yes!" they all called out. Martha asked, "Do you all understand how you're going to do this paper?" One student said, "I want to go home." The teacher did not respond that remark. Students worked independently on their worksheet, and the teacher walked around the room with a cheerful demeanor, stopping at individual student desks to assist those who needed help. She was very patient, and asked leading questions to offer assistance. Some students talked and collaborated, but there was no explicit means for collaboration. Most students completed the assignment after five minutes.

The First Year

Early experiences and perceptions. Martha missed the first two days of professional development for the project, because she was on maternity leave, having had a baby during the summer. She attended a make-up session with six other teachers who missed the opening summer session. Martha was concerned that she would be behind. After completing the first two days of professional development, Martha noted in her letter of intended practice, that her students would create a comic strip on the computer. She planned for them to work in small groups, each with a specific role:

> "The kids will have to play with clip art, and other programs available to create a story using their imaginations."

By November of 1998, Martha had participated in four full-day sessions of professional development. During a follow-up visit with the third grade team during their planning period conducted in conjunction with the fourth professional development session,

Martha asked a question about organizing her classroom with learning centers. She said she didn't know how she could do it. She was looking forward to the professional development session, and hearing about how teachers had been managing the four computers in their classrooms.

The fourth session involved using new software called Inspiration. Each teacher wrote an open-ended reflection at the end of that session. Martha wrote:

> "I thought I was the only one that was hesitant to begin using computers in the classroom. But as we meet in each session, I hear the different opinions and experiences that everyone has gone through. It makes me feel better that once the fear and overwhelming feeling has passed, a certain amount of excitement begins to happen. I feel rejuvenated right now, and I know I can go back to the classroom and try the new ideas that we learned in the last session. I think I'll start small and use the Inspiration tool to allow the kids to map out their ideas from their AR books. It can also be a good incentive to help them finish their books. I would also like to plan out lessons, using this tool. The kids would begin to feel more comfortable, if they use it everyday. We are writing stories in class on animals, using descriptive words. The kids think it's fun to describe an animal they were talking about. I had a good idea today, on how to use the computer to extend this lesson. We could use the Free Lance Graphics to make a slide show, using text, and the last slide could show the picture that is being described. I'm so ready to try this. I feel better now and as I talk to the other teachers, asking questions and sharing experiences, it makes me feel more open- minded, and willing to try new things. Thanks for your gentle push and guidance. I'm going through a pleasant journey, learning new exciting ways to teach!"

In this reflection, Martha shared her concerns for using the computers in her classroom, yet she was thinking of the computer as a tool to improve student learning. Four months earlier, Martha would not have written that paragraph. In her reflection, she named two software applications and had numerous ideas on how she would integrate that software as a tool for learning. She kept in mind how students would use the tool, in keeping with her philosophy of students learning best from hands-on experience.

During a follow up visit the second semester, four of the third grade team members, including Martha, requested a mini technology session to go over file structure and the various places they could save on their computer. They were concerned about writing their lesson plans and saving them to a disk.

Designing instructional activities. During an informal classroom visit the second semester, Martha shared her students' work with FreeLance Graphics, the presentation program of Lotus SmartSuite. Each student had created a computer slide show and

given an oral presentation, to show their project to the class. Martha's students had done the project she described in the previous reflection.

At that point, Martha was interested in using Inspiration software with her students, for creating a story map with character, setting, and plot. She talked about the lesson plan she would be required to do for the SEDL project, and decided to use the FreeLance Graphics slide show lesson. She planned to put the lesson plan in her teacher portfolio, which she compiled as a form of teacher evaluation. She noted that she thinks that the lesson plan is a good idea and complements the work she is required to do for her teaching portfolio.

Martha wrote her lesson and presented it to her colleagues at the last session of professional development for the first year of the project. In her lesson plan overview, she stated:

> "The student will write a descriptive paragraph about an animal of his choice and present it to the class as a riddle. The student will create a slide show on the computer and present his riddle to the class."

In describing her instructional strategies she stated:

> "Cooperative groups were initially used to discuss and research information about the animal the student was going to describe. These groups were used to brainstorm, research, and take notes on descriptive words to use when writing the paper. When working on the computer, groups were established according to the level of knowledge in computer skills and Freelance Graphics program."

Each student was responsible for his or her own animal riddle and slide show, although students worked together on brainstorming, research, peer editing, and computer skills. Each student worked at his or her own pace.

In her reflection about the constructivist principle, *Learning is internally controlled and mediated by the learner*, Martha stated:

> "Each student progressed individually, and he was comfortable learning at his own pace. This enabled the less proficient student the opportunity to take it as slowly as he needed to. He had the resources he needed through his partner, and was given the chance to learn by that partner. He did not feel that he needed to produce first, but understood that he needed to work as hard as his partner did."

Martha wrote in her lesson plan that putting their written work in a slide show format was very motivating for her students. They enjoyed seeing their work in a professional format on the computer screen, immediately. Each child wanted to create a slide show different from his or her peers. In addition to sharing their animal riddle slide shows with their class, students shared them at Parent/Teacher Conferences, and parents were pleased to see the work their children had done on the computer.

Martha described the most challenging part of the activity:

> "The most challenging part was when the students were helping each other on the computer. They also had trouble explaining the process to their peers, without touching the mouse, or the keyboard. Since I did not have any prior knowledge about the computer or the program, it took awhile for all of us to feel comfortable enough to progress at a rapid pace. We took our time and I think that gave us the opportunity to explore more, and therefore learn more."

Martha concluded about her lesson plan:

> "The lesson was wonderful to see as it manifested throughout the week. I enjoyed being the facilitator, once the lesson was explained. I sometimes felt like I was being pulled at different directions, but I realized that each group had different needs, and I felt that the whole class, including myself learned so many things. The fact that the computers are right there, just for us to use, gave us the freedom I wish all classrooms had. We no longer feel like we have to use the computer. We now want to use the computer for everything we do in the classroom."

End of year progress. Martha's classroom was observed for forty-five minutes for the second time in the spring of the first project year. This was her monolingual third grade class, with approximately the same students she had at the beginning of the school year. Six girls and eight boys were in class. It was the beginning of the school day, and the students were moving to their assigned centers after the morning announcements. The transition was smooth and students knew where to go. Martha announced, "Everyone brought their homework! Isn't that great!"

The room was organized with five groups of table and chairs. There were four centers around the room labeled in bubble letters: art center, writing center, math center and computer center. One student reminded the teacher she had not switched the name cards for the learning centers, and the student offered to do it. The teacher agreed. At one center one boy and two girls each worked on their own worksheet entitled "Seeking Out Safety," with scrambled words and a word search. At another table, two boys also did the "Seeking Out Safety" worksheet. Students did not give answers to each other on the safety worksheet, but offered each other clues to find the correct answer. At another table, one boy worked alone on a writing assignment about a personal injury, entitled "Owie."

At the art center, a boy and a girl were each making a windjammer with construction and crepe paper. They used a master pattern and directions. At the math center, a boy and a girl used a deck of playing cards to practice addition. One child selected two cards and the other child added the two numbers from the playing cards, and wrote the sum on a piece of paper. Then they added that number to the previous total on the paper. They took turns and switched roles. At the computer center, four students worked individually on their writing assignment, a story that was set in a swamp or marsh. Two students used their first draft print-out, and edited the first draft based upon Martha's written comments and corrections. The other two students were word processing the first draft of their story.

All students were on task, and talked quietly to each other and gave suggestions. Martha walked around the room offering assistance as needed. The students completing the safety worksheet had a disagreement and called her over. Another student asked her a question and she replied, "Who is your partner? You should be talking to your partner, not me. I'm not giving you the answer." At the art center, Martha observed the students and laughed with them about an event from the previous week.

At 8:30 am the centers work stopped and reading time began. Students smoothly transitioned to the new activity and knew the routine. This time was devoted to individual reading of books, taking a test on the book using the AR software, and record keeping in student reading logs. Martha shushed the class to begin reading. A number of students needed to talk to her individually, so six students lined up to see her at her desk. Four students were at the computer taking their AR tests, while seven students sat on the floor and waited for the computers to take their AR test. After a few minutes, Martha asked students on the floor to go to another space and read a book while waiting. "Guys, be quiet, some people are trying to test," she said, and the class quieted down. Other students sat around the room in various comfortable positions to read. One child put a blanket over a chair to make a tent and read with some stuffed animals. Another child used a blanket as a pillow and reclined, reading on the floor. A student teacher entered the classroom, and one girl ran up to him and hugged him. This was the end of the observation time.

Two major changes were noted between the first and second classroom observations. In the second observation, students seated in small groups were engaged in different activities at different times, and the computers were integrated into the learning environment.

On her second technology skills self assessment for SEDL, completed in the spring of the first year, Martha marked herself as experienced in 13 skills and as having some experience in 19 skills out of a total of 86 skills. She now had some experience with word processing, spreadsheets, drawing software, a browser and email on the Internet. The software she reported using with her students was Lotus Word Pro, Write Along, FreeLance Graphics, and Accelerated Reader.

The second year

Changing circumstances. Martha began a new teaching assignment for the second year of the project, serving as an English teacher in the third grade dual language program. Dual language classes are provided in the first through fourth grades. This approach at Martha's school pairs one primarily English-speaking teacher with a primarily Spanish-speaking teacher. Two classes of mixed language students spend alternate days with each teacher. In the classroom, students work together: native Spanish speaking or native English speaking students work with each other to translate for each other. The teachers who share the same students, must plan together, to keep their lessons organized for optimal student learning.

Although Martha is bilingual, she served as the English teacher in a dual language pair, one of two dual language teaching teams at the third grade level. In her classroom, she spoke only English. At the beginning of the year, students were allowed to speak to her

and to each other in English or Spanish, while later in the year, they were supposed to only speak in English while in her classroom. After learning in the English class for a day, the next day, students went to the Spanish teacher. Each teacher was responsible for teaching all of the subjects to their students. A lot of coordination and planning between teachers was required.

In addition to the students learning with mixed language children, students were to meet for one hour per day with their native language peers and teacher. Martha met with the native English speakers and taught language arts: writing, spelling, and reading. Her students used the computers for writing and Accelerated Reader.

Designing technology-assisted instructional activities. Martha reported that she uses the process approach when she teaches formal writing to her native language speakers. She had used this approach for a number of years, and the part she recently added is for students to word process the final draft on the computer.

An early formal writing assignment was the "how – to" paragraph. Martha introduced the idea to the whole class by having them verbally give her specific directions on how to walk from her desk to the door. She followed their directions and stumbled when they were not specific enough. The class then discussed the specific elements of a "how-to" paragraph, and they read examples of paragraphs from previous years on the overhead projector. Over a few days, they discussed the vocabulary in the samples and brainstormed topics of their own. The students worked in small groups to write the sequential steps necessary for their selected topic. The whole class discussed appropriate time and direction words needed in a "how-to" paragraph. As a small group, they reviewed their steps to make sure each step was included with appropriate vocabulary, and then shared their draft with the teacher. The small group rewrote their steps to make them clear, and then they shared their "how-to" paragraphs with the whole class. For example, one group wrote steps for making a paper airplane. As the writers read their steps out loud to the class, the students in the class followed along and tried to make a paper airplane. If the class got lost, the writers made a note on their draft to improve the directions by clarifying, adding or omitting steps. After this, each student was responsible for producing his or her own final draft through word processing.

Martha incorporated a combination of whole class, small group and individual strategies in the writing process. She began with the students' prior knowledge and experience by having them give her verbal directions on how to go from her desk to the door, and engaged students as active learners when the class had to follow a small group's directions. She also provided for social interaction by having the students discuss their ideas as a small group, and present their ideas to the whole class. The final draft of the writing assignment was word processed on the computer by individual students and was assessed for correct grammar and mechanics, along with including the elements required for that style of writing. Martha also made sure all of the TAAS objectives were fulfilled, so students were prepared for the writing TAAS in fourth grade.

Martha also provided opportunities for informal writing for all of her students. All of the dual language students wrote in their response journal on a topic of their choice every

Friday. They were required to write at least half a page, and could include a drawing with their writing:

> "We have response journals where they write to me and I write back to them. And it is a lot for me to write in every journal so we do it only once a week. But, I get to write to them and they read them on Fridays and then they respond to me."

> "They get to talk to me and ask me questions. And I ask questions of them and I ask them how their week went, and any problems they're having. They talk about what they did with [the other teacher in the dual language pair]. I thought at first it wasn't working ... We were writing all week. And I thought if I include another activity on Friday, and we write, they might not want to write anymore, but because they're talking about themselves and some of them volunteer to read it out loud to the class, it was like a treat to them. So, I thought, well we're going to do it and continue, and they loved it."

Martha explained that she learns a lot about her students by the stories they tell:

> "When I first meet them, I have to listen. Because they all have a story to tell and they have different backgrounds and different lifestyles, and if I don't know where they come from then I don't how to move on."

She said she learns more about her students through their writing:

> "Many times they tell me if they have books at home, if they go to the library during the summer months. I learn a lot from what they tell me. Many times they tell me that they live with their grandparents, that maybe doesn't speak English. So, I know that's going to be a problem because of the fact that they don't have that at home. I realize they have more of a need here at school ... Their writing tells me a lot. Some of them don't like school. And you wonder why not? Why don't you like school? You'd rather be outside, or ... Or they tell me it's the opposite, with a lot of the girls, they love to be here."

In language arts with her mixed language group, in addition to writing activities, Martha designed a lot of activities around oral language use and more basic skills such as phonics and reading. Her students worked in cooperative groups:

> "I realized that if I paired them up, somehow together, they did much better than me being in front of the classroom talking ... Because they have to hear the other kids speak English, and not just myself, but the other kids that they are working with."

Martha said she worries about the English language skill level of her English native language students. She did not want them to fall behind the traditional monolingual students, who were not in the dual language program. She expressed concern about the TAAS and meeting the needs of all of her students:

"The first time is always difficult. Like this year, with dual language. It's been very difficult. But I know I will do better. Because hopefully I will be doing dual language again."

During the second year, Martha made the most dramatic change in her instruction. This change was a result of the dual language curriculum at her school and the ATRL project training. Because of the dual language setting and her understanding of how to integrate the computer, Martha's students worked in small groups daily, for every subject except math. Martha integrated the computer whenever it fit with her curriculum by using the four Internet-connected computers in her classroom. Her students used the following applications: presentation, word processing, paint, spreadsheet, the Sticky Notes of School Vista, Inspiration, HyperStudio and the Internet.

In the second year, science and social studies were the subjects where Martha made the most changes:

"I never had them work in groups for science and social studies. That's the area where I just changed dramatically. For science and social studies, I would have each day a lesson taught ... We used the textbooks ... The end of the week we were done with that chapter and then we go on ...We would discuss. We would read the chapters. We would answer questions. I did that for a few years. And in that area, everything changed."

"I know our textbooks aren't used that much now. I know that whatever question a kid might have, if I don't know it, we go to the Internet and look for it. We'll find a way."

Martha began devoting her afternoon class time to thematic centers around topics in science or social studies. She moved away from following the textbook. The students used the Internet for research. They worked in pairs with one predominantly English speaker in each pair:

"I don't know, it didn't dawn on me at first. But centers were the way to teach science and social studies, whereas before I didn't."

"Now what we do is we discuss what we think we're going to learn. They ask questions about what they want to know. They want to know how to look for the answers, not solely in the book, but we use library books, we use the Internet, all the other resources. We discuss how we are going to find the answers."

"It's a lot of group work, where I'm going from group to group to group all day long and somehow it all fits. They all finish what they are supposed to do. The week is long, but they all finish everything and they understand. And the following week when I reteach, they learned it, so I know it's working."

Martha's students were independent learners, engaged in their learning. They collaborated to share their questions and learnings with classmates:

"I know they need to work in groups whereas before, it was very individual. But now, the fact that they are working together I think they learn so much more. They share everything and it is a loud classroom because of it. But they share everything they've learned. Even when they were playing the games this afternoon they were able to pick up the rules so much faster because someone was there with them. And the language barriers are minimal now because they are working together."

Martha noted that she considers many things when she creates her science and social studies centers. She needed to make sure each center fulfilled the curriculum requirements of the state standards of the TEKS, the Texas Essential Knowledge and Skills. Each center should be able to be completed within 20 – 25 minutes, and needed to be equally interesting, so that students would be motivated to do the learning at each center, and not just the computer center. Since Martha did mostly thematic units, her centers needed to relate to the selected theme. In addition, she needed to take into account the grouping of the students at the centers. And finally, the computers were one of the centers, with the lesson integrated with the thematic unit.

Martha explained that she assesses the students each week, according to the work they completed at the centers:

"When we finish the week, it's all one packet. And I tell them if one is missing; you don't have the packet. And I grade them that week."

Near the end of the year Martha's class finished a three week project on scientific categorization, using the school's recently purchased Inspiration software. They were preparing to work in HyperStudio next, another new software program the school had just purchased. Although Martha had never used HyperStudio with her students, the students used HyperStudio with the Spanish dual language teacher, so they had some familiarity with it. She planned to build upon their familiarity, just as she did with Inspiration software. Martha commented:

"I think every year our kids will be smarter when it comes to technology. We don't have to start at square one again."

The Inspiration software project was the one Martha wrote about in her second lesson plan. For this project, students categorized living and non-living things, with a focus on plants, using Inspiration software. Students began with the information in their textbooks, then used the Internet to find more information about specific plants.

In the Instructional Strategies section, Martha wrote:

"Cooperative groups were first established to research each topic. Paired groups worked on computers to introduce the computer program. Individual work was continued to finish the outline."

Martha noted student reactions:

"The students were very anxious to use the Internet to do their research. It was very nice to find out that some of the students had already been introduced to Inspiration and were eager to explore more. They were able to tutor the kids that had not used Inspiration, and help each other as the lesson continued through the different stages."

In response to the question, *Describe a challenge that you experienced with this unit. How did you resolve it?* Martha wrote:

"I had never used the Internet myself to research the lesson, and I found having to search through the sites many times before I actually taught the lesson. I felt I needed to facilitate but found myself exploring alongside the students. The students helped me decide which sites were suitable when researching a particular kind of plant. I had never used the Inspiration Program before this lesson and the students were great in helping me become familiar with the program. It was great to learn new methods to use while teaching the students about something that I had taught in previous years."

In response to the statement, *Describe a success that you experienced with this unit,* Martha wrote:

"The students can remember every bit of information they learned about the types of plants, even now after several weeks after the lesson has been taught. They can pick out all the conifers around the school and can tell you the characteristics of each kind of tree around the playground. The kids are more aware of the kind of plant-life that [the community] has to offer."

When Martha shared this unit with her teacher colleagues at the final professional development session, they were very supportive of her lesson and impressed by her student's work. In her comments to Martha, a first grade teacher wrote, "I love how you used Inspiration! I would love to have your kids team up with the little ones next year!" Another colleague commented, "Good for you — learning along with your students. Makes me want to explore Inspiration."

In the dual language program, Martha had her native language group and her mixed language group. Each child used the computer one or two times each day, for something more than Accelerated Reader. During the dual language time, she paired the students based on two areas, computer skills and English language skills.

Planning and organizing for instruction. Martha said she finds that the biggest change for her in teaching with thematic centers where the students work independently and the computer is integrated is that it takes her longer to plan and she has to be very organized. In the past, she could decide day to day what lesson she was going to teach and she could easily make changes by the day if needed. Now, she said, she plans by the week:

Well, I plan week to week. I don't plan more than a week because something always happens where we have to change something.... They're doing well because I learned to make the lessons fit for about 20-25 minutes. ... Because now

> I'm planning the lessons through the Internet, I need to plan at home. I didn't want to stay here at school, after school and plan. So, now, I get to do it at home. I plan the lessons that we are going to be using for the following week at home. It's better... I have to plan a little more, and I have to find time outside of the classroom to plan for that. But once I plan it and we go through the week it works very well. If I didn't plan, it wouldn't work out. ...So, that changes everything for me. I have to plan what's going to happen Monday through Friday, whereas before, I could just very easily change from one day to the next. ... If I didn't like the next day's lesson I would just switch it to something else. Now I have to follow through because it's a week's cycle.

Since she had taught third grade for six years, Martha was familiar with the third grade curriculum:

> "The only thing that is different is the technology benchmarks. Because now we have to include them in our lesson plan. And I do have to go and check to see that certain benchmarks are included. And that I have written them down. Everything else I'm more comfortable with third grade curriculum. It hasn't changed that much other than the wording."

She explained that it takes her awhile to plan the activities for each individual center:

> "Like when we are doing dentistry and teeth, and all the other centers were related to that. When I'm doing my lesson plans, I usually try to find the one they want to have for centers. That way if they're interested then they won't mind going to the other centers. But if they're just math, science, they all just want to go to the computers."

Martha planned with the third grade team on selecting science or social studies thematic units. Each of the teachers was responsible for different units, and shared their activities with the others. In addition to the dentistry and teeth unit they did the following thematic units: Dia de los Muertos (Day of the Dead, a Latin American holiday) and other traditional holidays, Cesar Chavez, Mexican Cowboys, Weather, Living and Non-Living Things and the Solar System.

Using technology in the classroom. As the preceding section illustrates, Martha integrated student use of computers into a great many of her instructional activities. It wasn't an easy process for Martha to decide how her students learned best and to integrate the computers in a meaningful way:

> "When they're at the computers, they share ideas, where all of them are working together anyway. I started with five and I realized five is too many centers. I just ran out of time and then I'm pushing them too fast and they're not giving me quality work. So, when we switched to four, they told me this seems to work. Because they do have half an hour now at the computers ... It's three centers plus the computers."

> "It's taken me all year to finally figure it out. I could not find a way to have them go to computers while I was teaching. I tried that. And it was very confusing.

> Where I would teach a lesson while half the classroom was back here and ... then we would switch and I had to teach that same group again. And it was too difficult for them and too difficult for me going back and forth. So centers, we realize, we have to make it work for them to go to the computers everyday. And it worked. So, I know next year I won't have to go through this ... You know, I really ... only teach about an hour a day ... Teaching has been fun. It has been a lot of fun."

Through the school year, Martha changed how she grouped students at the four computers. At the beginning of the year, they worked at the computers in pairs:

> "Because I wanted to have them all to go to the computers, and I paired them up. But, we just don't have enough room back here. And then one student always took the mouse and didn't let the others. And I decided, well, why don't we split that up and make another center. Then we have four kids working on the computer. But, then that meant I needed to help them more. They couldn't ask their buddy that was sitting next to them. But, I think this way they learned a lot faster because I'm sitting here, and I'm telling them how to find something. Like ... go to file ... go to edit. They're able to do it without me having to go and show them. I used to point a lot and now I don't ... They're a little more self-sufficient back there by themselves. But, now that we're starting a new program, I have to spend more time with them."

Martha noted that she feels she has been successful with all of the software programs and computer peripherals that she has tried:

> "I have been successful with all the ones that I've tried, but only because I felt, 'Okay, I'm comfortable in using it.' I haven't used the scanner yet; I still need more time for that. The only thing that I worked on this year was the digital camera. I wasn't' sure how to make a picture come out of the printer from a camera. [Another teacher] and I did that as a group project. And that helped me. The Internet research takes some time and knowing what is appropriate for the kids at their level ... A lot of the information is high level. The reading is higher for my dual language group, so I know I have to find things that are to their level. And that has me searching for the stuff that I need first, before they go into. If I let them just search then we might not get the information that they are looking for ... Before Yahoolligans, ... we were going through other search engines and I felt like this wasn't for school age children, but now that I know a little bit more about the different search engines out there, I'm able to find them [web page resources] quicker. And then the kids are able to find them quicker, too. They have gone into Yahoolligans so many times, they know how to go in and search for what they need. They are very independent in the afternoon now. I'm just standing there and watching them do all their work. They still ask me many questions, but I feel they are really moving at such a fast pace now."

> "They [technical support] come in during our breaks to help us or if not, at the end of the day. I know I learned just because I have to fix it at that time. I learned to reconnect the printer or to reboot the computer itself when it freezes. I learned to do that because I can't wait for them to come in and do it. So, very slowly I'm

learning how to see what's wrong, how to fix it. If I can't, then I call for them. Or I call my neighbors; sometimes they've had the same problems."

During the second year, Martha also acquired a computer that she worked on at home. She had resisted buying one, even though her son wanted a computer:

> "He is in tenth grade. So, he uses the computers at school and saves on disk. Then he would go to my sister's house and he had to work there. So my sister kept telling me, 'Why don't you get one yourself?' He would spend the night over there on weekends; he would use the Internet ... He told me last year, 'I need a computer.' I felt I didn't need one. I thought, no, we don't need a computer at home. But, since I started doing the grade book, I felt, I need to do this now. So, I went ahead and did it. It has been fun ... Sometimes late at night I'm able to go into it a little faster and do my research ... Because before, my son is on it. Then my daughter, I got her hooked into it. She is only four. She's only four and she's able to go to the Barbie site. She clicks on it and plays games. She's only four and she's learning."

At her home, Martha said she uses her computer about three nights a week for about an hour for school use, usually for finding Internet sites which relate to her lessons and doing her gradebook.

By the end of 72 hours of professional development with SEDL, over a two year period, Martha had made dramatic progress in her technology skills. On the final technology skills self assessment for SEDL, completed by Martha in the spring of 2000, Martha ranked herself as "experienced" in 66 technology skills which included the following software: word processing, spreadsheet, drawing , presentation, and the Internet. She rated herself as having "no experience" in only two skills: using a Macintosh computer, and using an LCD projector.

Final observation. Martha's class was observed for a third time one afternoon in the spring of the second, final year of the project. The students were engrossed in their solar system unit. There were four centers around the classroom, where students worked individually to complete activities and gather information about the solar system. The furniture was arranged in clusters with desks and chairs grouped together in the carpeted room, and tables held materials. Students were dispersed at various stations, with some working on the floor. At one of the centers three students used the three computers to read a web page and write facts about a solar system topic such as planets, stars, the sun, comets, moons, or rockets. Two students were seated at a table with library books and web page print outs. Each student took notes on notecards about a particular topic of the solar system. Two students were on the floor looking at books with diagrams of the constellations. Each student drew constellations on paper.

At the fourth station, four students worked individually to proportionally form the nine planets from PlayDoh, place them on a table and order them according to their distance from the sun. Then each student sequentially pointed to the planet and told the teacher the name of the planet. Although the student work was individual, students talked quietly to each other and offered each other assistance. The atmosphere was informal, with some students not wearing their shoes, yet all students appeared to be engaged in

their learning. At the book resource table, one student commented to another, "Did you know that...?" Martha walked around the room, assisting as needed. She assisted a child at the computer. The child read the web page to her, and she questioned the student for understanding. At the constellation station, Martha reviewed the student's constellations, and noticed a missing point. The student looked in the book to fill in the missing point. The teacher quizzed a few students after they finished their model planets.

This was the second week of the solar system unit, which the entire third grade was studying. On the chalkbord was a list of Old centers and New centers. In addition to the centers described above were, My favorite planet is... , word search, and 5 facts. One side of the classroom that was covered with windows was devoted to a solar system display. Black paper was placed over the window with stars cut out of the paper. Through the cut-out, the outside light shone in the room. Over the black paper, part of the sun, made by Martha, was at one end of the display. The nine planets were student cut and colored, with an attempt to make them proportional in size. The planets were placed sequentially from the sun on the black paper. In the hall, black paper covered the ceiling lights, and the planets and other student-made objects in the solar system hung from the ceiling.

Looking Back, Looking Forward

Martha reflected upon her experience over the past two years:

> "At first the fact that I had to change everything was difficult and frustrating. I had to work through weekends planning and it was difficult for me to make it work. But, the fact that we were kind of, I don't want to say pushed, because we weren't pushed. But we were guided to use the computers more and to me that was a motivation to go another route. And to teach another method. And that was through technology. And it has been so much fun. It has been really fun because I'm learning. I didn't know it myself. At first I thought I would find a lot of stumbling blocks and then I would get turned off. But it has been so much fun because we haven't really been too stressed. But we have been guided ... And I have been very comfortable deciding, 'Okay, am I ready for the next thing or shall I stop for now.' I've been very comfortable. The other teachers are doing the same thing. We share a lot and we have Ms. X, who knows so much about computers and she is so willing, and we all help Ms Y. We share ideas. Third grade is really unique. We are really comfortable working together. But I think it has been so much fun using the computers and all the programs that we have this year."

> "Other teachers have so many ideas that they share with us. They are always there to help. I don't see anything that keeps me from doing what I want to do. The only thing that I really have to follow is the dual language schedule."

Martha said she feels comfortable with her change to a more learner-centered classroom. She explained that her goal in the next two years, is to teach math in a more learner centered way. Math, she noted, is favorite subject to teach. Her students used the manipulatives that she learned about through inservice in the district. In her

classroom she had pattern blocks, unifix cubes, base-ten models, hippos for counting tools, cuisanaire rods, geoboards, overhead strips and puzzles:

> "I mean, the kids are working and I am just guiding. And I know in two years, I can imagine the whole day being that way. It's already that way in the afternoon. Whereas, in the morning I still do my traditional teaching in math ... But, I'm still not comfortable with just letting them go, where let's say I'm teaching a new concept or a new topic and I can see them already working ... Cooperative learning is the way, really. Whereas before, it was a traditional lesson and then group work and then independent work. But I can see us going on the Internet for math. I still don't know how, but, I know there is a lot of math on the Internet that they can use. I don't know yet how to bring that knowledge into the lesson. But, in the afternoon is cooperative learning, all afternoon it's working in groups, doing their research while I'm watching, guiding and just floating around. But it's half a day now whereas before it was one hour a day. It's a lot of independent work ... I know math is the last thing I have to work on. So maybe in two years they will be able to share skills that they are learning at that grade level. I don't know. I'm just thinking, 'Well, what else can we do?'"

> "It was safe to work with science and social studies. But math is very specific. I know because TAAS guides us to teach the objectives and make sure that the curriculum is fulfilled at the end of the year. I don't know if we're able to do that. But I know cooperative learning has really helped this year. ... But in math, they need to master specific objectives and I'm not really sure how to do that. I don't know how to use technology equipment other than these games that are in the Internet or the CD Rom that comes with the programs. We haven't used it [the CD Rom], but I know there are other areas that I can look into."

> "My math is still very structured. I still haven't let go. But, then we are doing so well in math, I feel like I'm not harming the kids in doing that."

Martha's said her guiding philosphy of education is that:

> "I need to be aware of changes and the need to change things and not be afraid of different things. ... Every year I learn new things and I know I have to learn new things. The kids, I mean the kids are third graders every year. But every year, even though, maybe the curriculum stays for a year or two at a time without changes, you still need to find better ways to teach. So, I know that I still have so much to learn. I still don't think I'm a good teacher. I still think, I should have done this a different way. But I know that I have to continue learning ... I think, maybe because I'm hard on myself. Let's say, I teach a lesson that lasts a week and afterwards I sit and I think. It wasn't very interesting or the kids learned, but I could have done something else to make it more worthy for them. But, no I criticize myself."

> "Throughout the week the kids let me know if they are frustrated or some of the kids sometimes will say 'I don't want to do this, I don't want to go to that center, I would rather go back to the computers.' They tell me what works and what doesn't, and I have to listen to them. They tell me 'I don't want to do that center

again next week. Can we change it?' And I have to listen, because then they won't like it. But many times I go through the week and I think, 'Could I have changed maybe a lecture that took too long? Should I have shown a video because they love to watch videos? Was there another way that I could have found?' Even other teachers ... because we do share a lot, we sit and talk and I think, 'I should have done that.' But there are always choices I can make.

"I know my kids are learning. And I know that in the year I'm able to teach all the objectives that I'm supposed to teach and all the lessons they need to know. And I think it's important that I teach it where they're able to remember and the experiences they learn goes on with them. I think that's important. I don't want to teach something that I know they'll never use later on in life."

Discussion and Conclusions: A "Learning Centers" Environment Assisted by Technology

Martha's first formal classroom observation indicated that she had a low technology, moderate constructivist classroom. By the second formal classroom observation she had moved to a moderate technology, moderate constructivist classroom. By the end of the project, Martha's final classroom observation indicated that she had a moderate technology, high constructivist classroom.

The type of constructivist learning environment that Martha's classroom may be characterized as a "Learning Centers" model. The following paragraphs discuss Martha's instructional practice in terms of specific elements of technology-assisted constructivist learning environments. These elements were identified from the research literature and were incorporated into the observation protocol used by ATRL staff in collecting classroom data.

Teacher's Role. In her first classroom observation, Martha demonstrated the following characteristics of a constructivist learning environment in working with her students:

- Establishes positive rapport with students.
- Validates and shows respect for all responses.
- Facilitates, models and shares social and cognitive skills.
- Inquires about student understanding of issues and concepts
- Provides multiple ways of learning.

During this observation it was apparent that Martha had a positive rapport with students. She smiled easily and joked with them, though she required students to stay on task and attentive to their learning. When students asked questions, she listened, and respected each response. When a student struggled to give a response, she patiently waited, and offered encouragement. She constantly questioned for understanding, and waited for students to provide a response to her questions. Students used the hippo math manipulatives to guide their counting, thus she provided students with more than one way to learn about rounding three-digit numbers.

Later observations and informal interactions demonstrated that Martha reflected the following additional characteristics in her teaching role:

- Acts as facilitator and/or co-learner.
- Elicits student's prior knowledge.
- Provides opportunities for students to express ideas and experiences through technologies.
- Nests instruction within relevant, meaningful and real-world context.
- Encourages student autonomy and initiative.

Field notes indicate that, over time, Martha became more of a facilitator. No longer was she standing in the front of the classroom, giving instructions. Having four computers in her classroom that the students would use daily in support of the curriculum, forced her to change her teacher role. Martha did not think of herself as a facilitator, but as a co-learner with her students, as stated in her lesson plan reflection: "I had never used the Internet myself to research the lesson, and I found having to search through the sites many times before I actually taught the lesson. I felt I needed to facilitate but found myself exploring alongside the students. The students helped me decide which sites were suitable when researching a particular kind of plant." Students shared their prior understanding about topics through brainstorming activities.

In her second lesson plan, Martha allowed the students to guide a part of the lesson, and go beyond her original expectations. Again, technology was the driving force. Through her students, she learned about the capabilities of the outline feature in Inspiration software. The technology served as a way to allow the teacher to be a co-learner with students. The co-learner role branched out into other areas of the classroom. Instead of relying upon the textbook as the main source of information, the students' questions were guiding the research and it gave the learning a meaningful context for students, using real-world resources. Although Martha often relied upon the textbook as the starting point of information in science, she allowed the students to uses available resources to go beyond the textbook to ask questions which could be answered by the Internet and library resources.

Student Role. In the first classroom observation, Martha demonstrated the following characteristics:

- Draws upon previous knowledge/experiences to contribute to the learning activity.
- Uses raw data, primary resources, manipulative, or interactive materials requiring interpretation.
- Becomes an explorer, problem-solver or active participant rather than a passive observer.
- Can show evidence of understanding ideas /concepts.

In the first classroom activity observed by ATRL staff, students used their previous knowledge about rounding numbers to contribute to their understanding of rounding three-digit numbers. The hippo manipulatives gave them a concrete object with which to work. Students moved the hippo on the number line to help them solve the problems and round the numbers. Most students appeared to understand the lesson and were able to explain their responses. If a student did not understand, Martha worked with the student individually.

Later observations and informal interactions indicated that Martha's students also exhibited the following characteristics:

- Interjects personal experience and understanding.
- Constructs new meanings from tasks at hand.
- Uses a variety of both technology and non-technology materials and tools for learning.
- Uses technology to access information that is otherwise unavailable.
- Raises questions for exploration or identifies problems to be solved.
- Designs methods for answering questions or solving their own problems.
- Uses mistakes as valuable learning tools.

Again, the introduction of technology influenced the changes in Martha's students' roles. In subsequent field notes it was documented that student likelihood to interject personal understandings increased. In their FreeLance graphics presentations the first year, each child worked toward creating a unique slide show. Martha wrote in her reflection:

> "The students were eager to work through the entire process. They liked the fact that it would be 'secret' until the class could try and guess what their animal was. The students loved working on the computers. They had never worked on Freelance, so they were very curious about the clip art, and the different functions, they could choose. They all wanted to make a slide show that was totally different from their peers."

By the second year of the project, Martha incorporated the Internet regularly into her lessons. When students made their Inspiration diagrams, they accessed information and graphics from the Internet. The Internet was not their only source of information. Books and magazines also were regularly used for gathering information. In the solar system lesson, magazines, the Internet, graph paper, index cards, and PlayDoh were used. Students were allowed to extend their understanding of topics by the individual research they did of specific topics of the solar system.

Martha did not limit her students to specific guidelines she created. When students made their Inspiration diagrams, they were curious about the outline feature, and learned new features of the software through their own exploration. They also chose to import graphics from the Internet, and not only use the graphics that came from the Inspiration software application. Students were able to easily correct any errors made, when they used the computer.

Curriculum. The math lesson conducted during the first classroom observation did not reflect any of the characteristics identified by ATRL staff members as representing a constructivist learning environment. The math lesson was rather abstract and did not appear to hold meaning for the students. No authentic, real-life examples were given.

Later observations and informal interactions, however, indicated that Martha's classroom reflected the following characteristics:

- Problems are meaningful and relevant to students.

- Structured around complex or many faceted themes.
- Provides opportunity for interdisciplinary learning.
- Stimulates thought and action through interesting, relevant and authentic problems.
- Activities include journaling, questions, and discussion to provide opportunities for reflection.
- Activities focus on developing higher order thinking skills through problem solving and exploration.
- Part of a larger instructional activity that leads to multiple opportunities for learning.
- Opportunities are available for self guided exploration.

Martha made progress in each of the above areas during her two years with the project. Although no item was a part of her regular practice, each one was something she did frequently.

During the second formal classroom observation, Martha's students were at learning centers with the computer as one of the centers, but the activities were discrete and not completely, thematically integrated. The centers were interdisciplinary with the following subject areas: the playing cards was a math activity, the patterned windjammer was art/math, the safety worksheet was health, the band-aid story was language arts/health, and writing and editing about swamps and marshes at the computer was language arts/science.

During the final formal observation, a major change was observed, in that the centers were thematically integrated around the social studies/science unit of the solar system. All of the centers related to that unit, a variety of materials were used, and activities were organized in support of that theme. This was at least a two week long unit, and one in which the whole third grade was participating.

In her interview and through field notes, Martha's curriculum exhibited more features of a constructivist learning environment that were not evident in classroom observations. In addition to the lessons within the thematic social studies units using learning centers, Martha reported ons other areas where she incorporated qualities of a student-centered classroom. For example, students wrote weekly in their journal on topics of their choice. They had opportunities to read their journal to the class, and the teacher read the journal and responded to the students in writing each week.

Classroom. In the first observation conducted by ATRL staff members, Martha's classroom reflected one identified characteristic of a constructivist learning environment:

- Emphasizes the activity of the student rather than the activity of the teacher.

Students' learning was the key to the observed math activity. Students responded orally in the whole group lesson, and in writing during independent practice. Although some informal collaboration occurred during this activity, there was no formal grouping of students.

Later observations and informal interactions revealed the following additional characteristics:

- Opportunities are available for peer collaboration.
- Opportunities are available for cooperative groupings or small group instruction.
- Students are engaged in different activities at different times.

Martha's students talked freely together and collaborated during their learning center activities. In both project years when the classroom was observed, all students completed individual activities, although they sat together at a table or on the floor. They did not engage in cooperative projects. However, this began to change. As result of the four computers being introduced to Martha's classroom, students were engaged in different activities at different times. In order for students to use the computer, they could not all be doing the same thing at the same time, in the way that Martha was accustomed to teaching science and social studies.

In the interview discussing her "how-to" writing assignment, Martha described the process of writing a how-to paper as very collaborative. Students negotiated the steps they needed to include as a group, and shared those steps with the class, before writing their individual paper.

Assessment. In the first classroom observation, the following assessment characteristics were observed:

- Uses ongoing assessment that is interwoven with student learning.
- Uses multiple ways to assess student learning.

In the observed math lesson, Martha assessed the students throughout the lesson by questioning them and asking them to explain their responses. She assessed their learning through whole group oral practice then through independent written practice. She also assessed some students individually through oral practice when she walked around the classroom, asked students questions and provided assistance.

Later observations and field notes indicate that Martha provided her students with multiple opportunities for assessment when they worked at the learning centers. At the end of each week, they were required to submit a packet to her, with their completed work. In addition, sometimes students completed long-term projects, as demonstrated in Martha's lesson plans. These were assessed in a variety of ways.

Martha explicitly addressed the multiple ways that student assessment was conducted in the first year lesson plan:

- The written paper will be evaluated by the teacher on grammar, punctuation, and how the student edited the paper.
- The slide show will be evaluated on proper sequencing of clues, on how the clip art was used to help the clues, and how the presentation was edited for the final time.
- The student will be evaluated on how he orally presents the slide show.

- The student will be evaluated on how well he worked with his peers.
- The student will be evaluated by his peers.
- Discussions will take place after each presentation to talk about whether adjectives were used to describe the animal. If the students have a hard time guessing the right animal, then the clues are probably not clear and specific.

Although Martha provided opportunities for students to work in collaborative groups and discuss their work, not many projects seemed to be fully collaborative. Since teachers were required to give students individual grades, it made planning cooperative lessons, where children were equally involved with an activity, a challenge.

As evidenced by the work at the centers, Martha often designed the centers with discrete tasks, able to be completed in 20 –25 minutes. But if students discovered a new topic of interest, she was willing to extend the lesson. With the introduction of the Internet into her classroom, students had unlimited sources to gather information to their questions. Martha sometimes assessed students at the centers by questioning them on their activity. For example, when students made the PlayDoh planets, students named each planet, and if they were incorrect, she gave them the opportunity to name the planets again.

School Context. Martha's school context remained the same throughout the two years of the project. Observations, interviews, and results from the Teaching, Learning, and Computing survey indicate that the following school characteristics played a role in Martha's successful development of technology-assisted learning environments:

Administrative support. Martha's principal was supportive of the project throughout its duration. He demonstrated this through his attendance at some of the professional development sessions,s where he participated actively in discussions and in some hands-on activities. He responded to teachers' questions about software, the new Internet connections in the old building and other questions related to technology at the school. He supported teachers in their creation of student centered classrooms. The school held Cyber Parents sessions in the evening and on the weekend, where parents came to the school to work side by side with their children, to learn about technology. For the final professional development session, the principal organized a catered lunch and musical entertainment, to demonstrate his gratitude to the teachers for their hard work. He served as an advocate in the district for improving the technology resources in the schools.

Technical support. Martha had adequate technical support throughout the project. A full time technology specialist was devoted to her campus to provide support for teachers. The specialist had a work order request system, and attended to problems in order of need. On her TLC survey, Martha marked that her technical support was very good and was available frequently. She indicated that she needed technical support weekly or more. In the second year of the project, Martha learned to troubleshoot some basic computer problems on her own.

Professional development. The ATRL project provided for 72 hours of professional development over two years. It was this professional development that gave Martha a

safe place to learn about technology and how it supports student learning in a constructivist learning environment. Martha also had opportunities for professional development to prepare her for being a dual language teacher.

Technology. Martha had four computers and a printer in her classroom during the life of the project, as well as access to twelve computers and two printers in the library. The software she had for the first year of the project included Accelerated Reader, Lotus SmartSuite, Write Along and the computer management system of School Vista as well as a reference CDs available from the library. During the spring of the first year, a digital camera was available and the school installed T-1 lines for Internet access. During the second year of the project Martha had a special needs student who required an individual computer, so she had five computers in her classroom. A new addition to the library was a scanner. New software available on each computer during the spring of the second year included Inspiration, HyperStudio and Student Writing Center. At the end of the second year of the project, the school purchased a digital video camera.

Time. The first year of the project, Martha's school had four afternoons of planning each semester, where the students went home at lunch time and the teachers had time to work together. The second year of the project, the principal arranged the schedule of teachers in dual language so they had a three hour planning block each month, with a substitute teacher for part of that time. Both years of the project, each day, the third grade students had PE at the same time, so the third grade teachers could use that time for informal planning and meeting time. In the TLC survey, Martha strongly agreed with the statement that, "Major staff development activities are followed by support to help teachers implement new practice." According to her interviews, she also needed to spend time planning at home, and that is one reason that she bought a computer.

Critical mass. At Martha's school, of the more than 25 teachers involved in the project, all of the first, second and third grade teachers participated in the ATRL project. When a number of faculty left the school at the end of the first year and new faculty were hired, all of the new first, second and third grade teachers participated for one year, thus allowing for a critical mass of teachers at those grade levels to participate in the project, most of whom had four computers in their classrooms.

Peer support. In her interview as well as in the TLC survey, Martha indicated that there was a lot of peer support at her school. This was verified through field notes, from visits to the school and during professional development sessions. In the TLC survey, Martha responded that the following interactions with other teachers at her school occurred one to three times per week: discussions about how to teach a particular concept, discussions about ideas for student or group projects, discussions where we exchange different views about an issue within our common subject area, visits to another teacher's classroom to observe their teaching and informal observations of my classroom by another teacher. Almost daily, discussions about computers, software or the Internet occurred. In addition, Martha indicated that compared to three years ago, she spent much more time: working with other teachers on curriculum planning, talking with other teachers about teaching strategies, spending time preparing lessons, and reflecting deeply about what good teaching is. She reported that the computer played a major role in most of the previous changes.

Pressure from external testing authorities. As indicated earlier, the Texas Assessment of Academic Skills (TAAS) is a test given for the first time in math and language arts at the third grade level. Martha said she always considered TAAS objectives when she planned lessons. Although the principal of the school did not put a lot of pressure on the teachers about the TAAS, it was an important part of the school rating system. Through analysis of data on diagnostic tests, the school provided after school help for students identified as needing assistance in meeting specific objectives of the TAAS. Martha said, "... I think this school is so special because we don't stress TAAS."

Personal attributes of the teacher. Martha exhibited several personal attributes that enhanced her capacity to change toward a more student-centered instructional approach:

Commitment. Martha was committed to learning how to integrate four computers in her classroom learning environment. She stated at the end of the fourth professional development session:

> "I thought I was the only one that was hesitant to begin using computers in the classroom. But as we meet in each session, I hear the different opinions and experiences that everyone has gone through. It makes me feel better that once the fear and overwhelming feeling has passed, a certain amount of excitement begins to happen. I feel rejuvenated right now, and I know I can go back to the classroom and try the new ideas that we learned in the last session."

As noted earlier, Martha tried many configurations in her classroom, before deciding on using learning centers for thematic science and social studies units. She was willing to change her style of teaching, in order to integrate the computers.

Technology skills. Martha made great strides in her technology skill level. Moving from some experience in only four skills and no experience in 76 skills the first time she assessed herself, to being experienced in 66 skills by the end of the second year, demonstrated that Martha felt quite comfortable using a variety of software applications.

Effective instructional designer/planner. Even though Martha had stated that she used centers when she taught first grade, she was not sure how to use centers with her third grade class. Though she did some projects and centers the first year, it was not part of her routine until the second year. Martha stated about the second year of the project:

> "At the beginning of the year, I started traditional. Like, that's all I know. But then, with dual language I had to throw that away. I couldn't do that any more. I was forced to change. And it had nothing to do with the computers or technology. It was just a group I had and I realized that me in front of the classroom teaching, was not the way to go. They weren't listening to me. They couldn't. They couldn't understand. I realized that if I paired them up, somehow together, they did much better than me being in front of the classroom talking. And then later on as computers came in and we started using the programs I realized that, 'I can do centers.' I don't know, it didn't dawn on me at first. But

centers were the way to teach science, social studies, whereas before I didn't. We used the textbooks. And very slowly we stopped using the textbooks."

Martha reflected upon her teaching, as evidenced in her lesson plans and throughout this case study. That is the first step toward being an effective instructional designer. She took into account the needs of her students and the curriculum, and designed effective and varied ways for them to learn.

Philosophy. In her TLC survey, Martha tended to indicate a leaning toward constructivist activities. Although she did not rate herself as definitely so, most of her responses indicated a belief in that direction. For example she strongly disagreed with the statement: "Students are not ready for 'meaningful' learning until they have acquired basic reading and math skills." And she agreed with the statement, "It is critical for students to become interested in doing academic work – interest and effort are more important than the particular subject matter they are working on."

Expectations. Martha demonstrated high expectations for all of her students. On her TLC survey, Martha categorized the achievement or ability level of her students as above average in native language arts, math, science and social studies and as very high in reading, both in English and Spanish. She modified the curriculum when necessary for her inclusion students, in order for them to achieve success in their learning: "I always have inclusion kids with different needs. And maybe with time I learned to modify the way I taught, but I noticed that they need to be involved, and they need the hands on activities, and they can't be just lectured, not in third grade."

Martha wrote a personal reflection after preparing her final lesson plan for the ATRL project:

> "I have learned so much on how important it is to teach students about all the possibilities that are offered to them. I feel privileged to be able to teach the kids about the latest technology available to them. I know that they will have no fears when confronted with computers. I think the students at [this school] are excited to learn more about what opportunities they can grasp, and I thank SEDL for sharing the wealth of knowledge that we were able to receive from them. I believe that our kids are prepared to take all the challenges that await them, and they shall readily accept them with no trouble whatsoever. They will be able to use computers to improve their lives, and to expect high goals because of their newly acquired knowledge."

Appendix 7

Urban Texas Case Study: Susan

A "Cross-Grade collaboration" model
of a technology assisted constructivist learning environment

Since her school had each hall divided into vertical teams with grades K-5, this provided Susan with many opportunities to have informal conversations with teachers at other grade levels, in addition to the required monthly vertical team meetings. To reinforce the vertical teams, the principal required all of the classes from each hall to do a presentation each school year. Susan utilized her vertical team to work with teachers and their students at other grade levels for unique learning opportunities and specialized projects. During the first year of the ATRL project, Susan's second grade class worked with a first grade class to create a student-illustrated, school song slide show created with Kid Pix software. During the second year of the project, Susan's first grade class met weekly with a fifth grade class during the second semester in the "Reading Buddies" continuous learning activity.

Community Context

This case study is set in a growing section of a central Texas city. The greater metropolitan area's population is over one million; according to the *American City Business Journal*, the city is one of the fastest growing in the United States. *Fortune* recently called it the best city for business in 1998. More than 825 high-tech firms operate within the metropolitan area.

The 1990 Census reported a population of nearly 500,000, 71 percent of it white, 23 percent Hispanic, and 12 percent African American. Sixteen percent of households were reported to speak Spanish as their first language. Median household income for the city was approximately $25,000 with five percent of households receiving public assistance. The 2000 census is expected to report substantial population increases, with the largest rate of growth among Hispanic families.

District and School Overview

For the 1997-1998 school year, this urban school district had a total of 76,606 students: 18,675 students in eleven high schools, 15,715 students in fifteen middle and junior high schools, 41,740 students in 68 elementary schools, and 476 students on four special campuses. The district's student population is diverse: 43 percent of students are Hispanic, 37 percent white, and 18 percent African American. Just over two percent of students are Asian, and .3 percent are American Indian. Half of the district's students are classified as economically disadvantaged; 12.6 percent have limited English proficiency. Thirty-six percent of students are college bound.

School site. The site school is a new elementary campus located near a major interstate highway, with open fields on three sides and housing on one. The area around the school is growing, as evidenced by the construction of new apartments and single-

family homes. Although the school is in a newly developed area, an established mobile home park lies within the boundaries of the school attendance area.

Children who attend the school are from primarily low-income families; eighty percent of the student population is classified as economically disadvantaged. Approximately 40 percent of the school's 510 students are African American; 40 percent are Hispanic; and 20 percent are White.

The school opened its doors in August 1998. The facility has 69,950 square feet of space and was built at a cost of almost $6 million. There are 32 rooms for classroom teachers, an art room, a music room, a gymnasium, two special education classrooms, a library, a teacher workroom, a cafeteria and kitchen, and additional office and meeting space. The school is designed so that the gym, cafeteria, library and reception area are in the center of the building, with the classrooms organized into four separate halls which span out from two sides of the center. This design allows for further expansion if necessary. Each hall currently accommodates approximately 125 Pre-K through fifth grade students and their vertical team of teachers, thus creating smaller "schools-within-a school."

Technology resources. The school has an up-to-date technology infrastructure with at least one networked, multimedia computer with direct Internet access in every classroom and office. Seven classrooms have four multimedia computers each, all with Internet access. There are five computers in the library. The school was designed without a computer lab to facilitate integration of technology into daily instruction in each classroom. A phase-in of four networked computers per classroom began the year the school opened. In addition to computers, each teacher has a telephone with voice mail.

The computers are Mac G3s with Mac OS 8.1. Software includes ClarisWorks, HyperStudio, KidPix Studio Deluxe, Netscape, Eudora, Story Book Weaver, Filemaker Pro, and JumpStart. In addition, the school maintains copies of Microsoft Office, Adobe PhotoShop, Adobe Illustrator, Adobe Photo Deluxe, and OmniPage Pro. Teachers and students have the use of eleven laser printers, nine color printers, and two scanners.

The district's technology plan has as its goal that students, staff, and administration will "use technology in a pervasive approach to maximize learning and productivity, encourage creative exploration, and manage the educational environment by establishing interactive, flexible, efficient technology environments." The district has established two technology leadership teams composed of classroom teacher: the District Technology Leadership Team and the Campus Technology Leadership Team. Teachers on these teams receive specialized technology training, serve as support personnel on their campus, write instructional units that incorporate technology and receive four multimedia computers for their classrooms. Eight classroom teachers at the site school have that training and computer equipment; the case study teacher is a member of the Campus Technology Leadership Team.

Introducing the Teacher - Susan

Teaching experience. Susan's teaching career began at an established elementary school in the same urban school district, where she taught in the second and third grades for eight years before transferring to the new school. Her first school, located in a high

socio-economic neighborhood, was named a Blue Ribbon School of Excellence by the US Department of Education, as well as being rated as Exemplary by the Texas Assessment of Academic Skills (TAAS). The demographics in that school — with 92 percent of students White and only three percent economically disadvantaged — contrast strongly with those of her current school.

Experience with technology. Susan began to use computers during her first few years of teaching. The first school where she taught was technology rich, with its own school-wide network that began with the initiation of a campus technology task force and technology plan in 1989. At the beginning of the project, she reported that she had used a computer at home for seven years and had been connected to the Internet for the past three years. On the Teaching, Learning, and Computing questionnaire, Susan reported that since she began using computers with her students, she has found them to be a very important part of her teaching.

Initially Susan had one computer in her classroom, and would take her class to the computer laboratory at a scheduled time each week. Her students did a variety of discrete short activities and projects in the computer lab. For one project, each student created their own drawing and description of a dragon in Kid Pix, related to the story *The Fourteenth Dragon*. With the assistance of the computer teacher, Susan put the story on the school's web site. Other applications the students used were word processing, and email, with a few ventures onto the Internet. The computer in her classroom was used as a teacher tool. Susan explained:

> "Because I was teaching whole groups, it was like the computer was more my tool than the kids' tool. I'll be honest. I used it for e-mail; I used it for word processing, creating spreadsheets, stuff like that. But it was more my tool than the kids'. The kids went to the lab and that's where they got exposed to technology."

Susan acted as a resource to her team, offering assistance with the computer to her colleagues. She also served on the school technology committee.

When the school district established the Campus Technology Leadership Team (CTLT), Susan and two other third-grade teachers at her campus were selected to be on the CTLT because of their technology skills. Teachers on these teams received specialized technology training served as support personnel on their campus wrote instructional units that incorporated technology and received four multimedia computers for their classrooms. When Susan moved to the school where she currently teaches, she was able to have four computers in her classroom because of her involvement with the CTLT.

Motivation for changing her teaching assignment. Susan reported that she decided to change campuses for two main reasons. First, her principal was asked to be the principal at the new campus; second, the teaching environment of her first school bored her. Susan had taught third grade for four years and second grade for four years at her first school. Susan said:

> "It was more old school traditional. You lectured to the kids. … there was hands-on. Math was very hands-on. But reading was, we ability grouped."

In grades two through five, students changed classes for reading and math based on ability. A teacher who had an average or below-average reading group had a higher math group:

> "I taught the struggling readers. But since they were all about the same ability, I taught the whole group. And we'd work on reading a book together. I'd assign chapters. They'd go home and read. We'd come back and discuss. It was kind of more like a book club. I'd help them with skills and things like that. I'd teach specific lessons but it was to the whole group."

Susan explained that she wanted a change:

> "I'd gotten into that rut doing the same thing over and over and over. I didn't even have to think about lesson plans pretty much because I thought, oh, well, I'll do the same thing I did last year."

> "The same book, the same unit, everything. ... I taught simple machines for three years. And I taught it to the entire third grade, because ... we decided to specialize because we had certain units we needed to cover. ... Each teacher took a unit and ... we rotated the kids so ... I'd be teaching one person's class simple machines. Another person was teaching my class electricity and magnets. I did that for three years. ... So I taught it 15 times. ... I was just so sick of simple machines. ... it was nice because I didn't even have to think about what to do. ... I just knew okay, this day we're showing the video, this day they're going to do this experiment ... I had all my worksheets in order and everything. Planning was a breeze. ... I didn't realize how rote everything had become. I didn't even have to think about it. That's how it becomes. ... I was bored basically. I was bored."

> "I never heard of doing centers in second or third grade. Or doing the Guided Reading, the Balanced Literacy. All of this was new. If it was out there before, I didn't know about it. Because things were done a certain way there and that's the way you did them. And you didn't deviate from them. And if you did, you were kind of considered, oh, she's doing something different and new. Things were done always with ability grouping. The same teachers taught those groups. We did the same units and all that. And all of that is good ... for any new teacher going into a situation ... everybody there was so cooperative, so helpful. Planning together because if you didn't know how to do all that, you had that support group. And you were kind of told this is what we're going to teach, this is what you're going to do. You were handed that. And that's nice for an inexperienced teacher, wow, this is what we're going to do because it was done last year and five years ago. And it's going to be done next year and the year after that. ... I didn't have to think. And I just wanted a challenge. I wanted something new. I wanted to do something different."

Although the day–to-day teaching had become routine and easy, Susan felt pressure in other areas. Parent involvement at her first school was very high, and sometimes became intrusive:

"Dealing with the parents there. That was hard. Because they were well educated. They expected a lot from you. They wanted you to be at their beck and call. I got telephone calls here at home concerning homework assignments and things like that. And I got to the point where, Randy [her husband] was like you're not answering the phone, you're not answering the phone. If someone calls for you, you tell them that you got in late and you'll deal with it when you get to school. Because people were calling me up and complaining because their kid got a B in math. Why didn't they get an A? ... I had a parent call me at home and was complaining about a B, an 87. Why didn't they have an A? ... You didn't want to make a mistake. When I graded papers, I constantly went over them again because I didn't want somebody coming back and saying you graded this wrong. It was that kind of hard. You know? And it was hard in that the expectations were so high, constantly trying to meet those expectations. We were an exemplary school. We had the highest TAAS ratings of the school district. And it's like once you're at the top, the pressure is there to remain at the top."

Baseline Information

Current teaching assignment. Susan was one of four teachers who moved with the principal from the established elementary school to the new campus. During her first year, which was also the ATRL project's first year of involvement with the school, Susan taught second grade.

Susan reported that she had many adjustments to make when she began teaching at the new school. One change that made her first few weeks difficult was the furniture in her classroom. In keeping with the learner-centered philosophy, every classroom in the school had round tables and chairs:

"...these tables. I was constantly saying, put it in your desk and the kids are like we don't have a desk to put it in. I'm like oh, oh, put it in your cubby. ... And I'd never worked with that before ... The first few days, in fact we were changing every day. The kids would come in and I'd be like, we're not going to keep your cubbies here. We're not going to keep individual cubbies. And I finally figured out what worked best for me and the kids ... And I was constantly going into everybody's room and going how are you doing this? How are you doing that? And everybody had different ideas. And that's kind of what I was doing. I was trying different ideas and seeing what worked for me ... And finally I came up with it. But the round tables, the cubbies, the centers, working with an individual, with small groups, while other groups were busy. That was new for me."

In addition to the new furniture and classroom layout, managing the student's behavior was a challenge:

"Discipline. It was a little bit harder ... The discipline required more effort than before ... Being very strict, very firm ... I'm like that already. But I knew I really had to follow through with that. When I said okay, this is your verbal warning. Next time I'm pulling your card to yellow. That's five minutes time-out. Really explaining that. And the kids seeing that I meant business. Before they might have had a teacher that said that, but they didn't act on it. Well, I was going to act on it. And they were going to do that time-out. Pulling them aside, talking to them

more, what's troubling them. Because I knew that here there was a deeper underlying reason for them acting the way they were. A couple of times kids were misbehaving ... and I pulled them aside and found out they were hungry ... Why are you acting the way you are? Especially first thing in the morning when there's no reason. Well, we got up late and I missed breakfast. Okay, would you like some breakfast? Okay, go down to the cafeteria and tell them that you missed breakfast and if they can give you a piece of toast or cereal or whatever. And I got to the point where I bought granola bars and stuff like that and kept them here. And I would say go around the corner, go eat this. Step outside and have this or whatever. Or just talk to them. Oh, I had a fight on the bus. Or so-and-so was picking on me on the bus. And just talking to them. And that's a lot of what I've been doing lately. Because they don't know how to deal with these situations. The way they deal with it and they see it on a day-to-day basis is arguing. They see when mom or dad or big brother or big sister or whatever, or aunts, uncles, whoever, in their life. Unfortunateiy, that's how they see people dealing with problems. Arguing, fighting. Getting mad. Cursing. That's how they see some people dealing with problems. And so I realized I had to talk to these kids and say that's not how you deal with it. You know? When there's a problem, you talk about it. I said come talk to me about it. I said, don't let it bother you. Is it a big deal that that person got to sit in that seat and you didn't? ... just kind of help them work through that. And so that's where I saw that discipline and managing discipline was going to be a little more effort than before."

With her new room arrangement, Susan had to work with the students on being independent learners, with children from a different background than her own or her former students'. In addition, Susan found that many of the students entered the second grade at a first grade reading level:

"And when I came here, it was like whoa. I mean, my brain hurt because I was thinking so much ... And here it was like I had to think about how we're going to line up, how we're going to get here, everything. And lesson plans. And that was a shock, too, because the kids— ability-wise, the kids were so much lower than the kids I had come from ... just having to modify and go okay, they can't do what I thought they were going to be able to. I've got to modify this. And then they got up to it. But, you know, initially, it was hard."

Even though Susan had so many new decisions, with a new community of students in a new school, she noted that her decision to change to a new school was the best one for her. She was especially excited about the independence to create her own classroom learning environment. The first year, the school employed four school-wide thematic units on the broad topics of communities, oceans, exploration and traditions; teachers had the autonomy to create their own day to day lessons around these themes:

[Here], it's just a different kind of hard. Plus, overall it's just a lot harder. But that's why I wanted to change. Wanted to do something new. I spent a fortune on teacher materials ... I'd run across apple units and ocean units and all these different things. And I thought wouldn't it be fun to teach that. But it was already set. This is what we're going to do. And I was like oh, man, I'd love to teach that. And me being a teacher, ... I learn when I'm teaching kids stuff.... I'd love to learn

about this and that. And I collected all this stuff. And I'd stick it in a file and say one day I'm going to teach this. Or I may need this. And the thought, when [the principal] said she was going to open up this new school, just the thought of I'll be able to go over there and I'll be able to set my own lessons and my own units and that was kind of exciting to me. That was very exciting to me. Because I thought I'll be able to use that apple unit I have in my file. Or I've had this unit on graphing that I've never been able to do in math."

"Everywhere I go, I'm looking. It's like oh cool. In fact, when we were in Canada, ... my sister and I found a book store. And we went in and what did I do? Walked in the book store, headed straight to the children's section, looking through all their books. In fact, I got about, oh, I don't know, I think I bought about $30 worth of books. Vancouver. Children's books. I found this, it was Mountain ABCs and it was so pretty ... because I love alphabet books and some of the pictures were like our trip. It said B for black bears. And we'd seen black bears. And just the mountains and everything. And I thought oh, I have to get this book. So I got that one. And then I found some other ones. But that's what I do. Any place I go, if I go to a book store, that's the first thing I do, go to the children's section because I love children's books. And then if I'm out anywhere, I'm like, oh, I can use this map. This can be used for directions and all that kind of stuff. So I keep all that kind of stuff. So I'm constantly thinking school."

At the new school and as an experienced teacher, Susan found herself spending a lot of time planning:

"Planning, takes a lot longer to plan. One, because I've accumulated so much stuff. Each year I go out and buy more and more teacher resources and everything. My first year I didn't have anything. So where I was looking for my materials was very limited as opposed to now, I've got closets full of stuff. So it takes me twice as long, maybe three times as long, because I'm looking for that one perfect thing to teach this lesson or to teach this skill."

In Susan's first school, the teachers planned together, primarily with grade level teams. At her new school, the halls were organized into vertical teams of grades K-5. After school, once per month the vertical team met to plan, and once per month the grade level team met to plan. Since the vertical team was on the same hall, they also had many opportunities each day for informal contact:

"And the idea of working in a vertical team. Before I was working on a grade-level team. We were all clumped together. And just working in a hallway where it was going to be K-5. And meeting new people."

Project participation. The school's principal was a major factor in the school's selection as an ATRL project site. In her previous school the principal established a technology program that was designated as exemplary by the state's Academic Excellence Indicator System. She sought to replicate this technology-rich learning environment in the new school, and to implement new initiatives by creating an instructional planning team.

This planning team, which included ATRL staff members, prepared a learner-centered, technology-rich, interdisciplinary instructional plan, which called for horizontal and vertical teacher teaming, as well as other strategies. These strategies created teacher-teams with responsibility for coordinating a student's educational program throughout his or her years at the school. Professional development provided by ATRL project staff was designed to complement the school initiatives; the campus co-developer at the school worked closely with SEDL staff to design the professional development activities. All teachers were required to participate in the ATRL project as part of their instructional assignment.

Before beginning the SEDL professional development each teacher completed a technology skills self assessment. On her initial self assessment, Susan rated herself as experienced in general computer skills, word processing, drawing, and seven out of eleven skills involving the Internet. She had some experience in spreadsheets and databases; the only presentation program she was familiar with was Kid Pix. She stated that she wanted to learn more about presentation programs.

Initial observation. Susan was first observed in the fall of the first project year, teaching 22 second grade students. The class was ethnically mixed, generally reflecting the school's demographics. Students sat at round tables rather than desks. Led by the teacher, the whole class was working on a language arts activity about the writing process. The previous day, each child had used a story prompt — a picture of a girl at a birthday party — to write a story. The class was discussing the revision process. Susan stood at the overhead projector with a sample story on the overhead. As students suggested revisions to the story, she made the changes on the paragraph, explaining to the class about how to make revisions. Some students wanted to write the story about a boy, but Susan said they needed to write what was in the picture, and not what they wanted it to be. Four computers were in the classroom but they were not used during this lesson.

The First Year

Early experiences and perceptions. After the first professional development sessions, Susan wrote in her letter of intended practice that she wanted her students to create a Kid Pix Halloween slide show. She hoped to see "students helping and sharing on the computer more." She was concerned that the students would not remember the many steps involved, and she planned to write the directions on paper. At a later professional development session, Susan reported that her students were able to make their Kid Pix pictures, but "we just don't have enough time in the day to do everything I want to accomplish. I really got a lot out of hearing what everyone else is doing. Anything I can learn about computers and software is greatly appreciated."

Designing instructional activities. Susan noted that she liked the drawing features in Kid Pix, and she used that software program in her required lesson plan for the ATRL project. Susan worked with a first grade teacher from her vertical team and her class on the Kid Pix slide show project. The lesson plan overview stated, "Students work together in multi-age pairs to design a Kid Pix picture that will be compiled into a slide show." The topic of the slide show was the school song. Each pair of students was assigned to illustrate one line from the song.

Susan listed her Instructional Strategies:

> "Project-based (A Kid Pix Slide Show), students are grouped in grade 1-2 pairs, preplanning on paper, teacher directed learning, peer instruction, computer lab time, and classroom computer time."

She described her procedure for creating the slide show as follows:

- Teacher reviewed with students the school song, the importance of it, who wrote it, and what each line means.
- Teacher led a class brainstorming of ideas for each line of the school song.
- Teacher then assigned each student pair a line of the school song to illustrate.
- Students worked cooperatively together to illustrate their line of the song using colors and markers.
- Students took turns on the computer to recreate their drawings using Kid Pix.
- Students were not limited to the use of Kid Pix tools, but were encouraged to do as much free style drawing as possible, editing of stamps, wide use of painting and use of the text tool.
- Students worked with a teacher to put together a slide show of the school song.
- Student pairs sang and recorded their line of song into the slide show.
- The slide show was made available to all classes on the school computer network.

Susan was asked to reflect upon her lesson plan. To the constructivist principle which states, *Learning is both an active and reflective process,* Susan responded:

> "The students were able to actively participate in discussion, design and creation of the school song slide show. The students were constantly reflecting on how they were interpreting their line of the school song."

Since Susan was familiar with the software and computers, her biggest challenge was not about the technology, but about scheduling time for the two classes to work together. Regarding the success of the project, Susan noted:

> "I was most proud that the two classes were able to work together to build school pride. Also, that the students were able to gain so many technology skills. The students really enjoyed working with their partners. I believe they learned a great deal. They especially liked recording their voices on the computer. Some student comments included: 'Ooooo, that's cool!' 'How does the sound get in there?' 'Wow, that's really awesome!'"

When Susan presented this lesson to the teachers at her school, her colleagues seemed impressed. She did her lesson in the computer lab, and gave the teachers hands-on experience with Kid Pix. One teacher commented:

> "This was definitely a learning experience for me, pertaining to the slide show. I like the fact that the two classrooms do collaboration, sharing and learning

together. The slide show presentation of the students was fantastic. Wonderful learning experience for students and teachers."

End of year progress. Susan's class was observed for the second time in the spring of the first project year. It was the same class that was observed in the fall, but only fifteen students were in attendance. This time, Susan's students were working in centers. One student was at an audiotape machine, listening to a story and reading along in her book; another student was at the flipchart center, copying a phrase from the chart; two students were making puzzles. A few students were seated at a table doing a worksheet, and three students were at computers using software to practice learning about money. Susan was with the remainder of the students, seated on the carpet, doing a reading activity. Two university interns were in the classroom; one was working with the students at the computers and one was observing. The daily assignment was on the chalkboard. Students working at the computers and completing the puzzles talked quietly to each other. The teacher stopped her reading group to encourage students at the centers to remain on task. Overall, everyone was active and seemed to be engaged in their learning activities.

Two major changes were noted between Susan's first classroom observation and the second: In the second observation period, students in small groups were engaged in different activities at the same time, and computers were integrated into the learning environment.

Susan completed a second technology skills self-assessment at the end of the first project year. She indicated greater familiarity with spreadsheet software, and she moved from the "some experience" to the "experienced" category with database software. She noted that she now felt experienced with the presentation software of Kid Pix and with technology peripherals such as a data projector, scanner, and the TV as a projection device. She noted "some experience" using a digital camera.

The software applications she reported using with her students were Clarisworks for word processing and drawing and Kid Pix. For her own administrative purposes, she noted that she found the software Gradekeeper useful, because it allowed her to keep her students' grades on the computer.

After the struggle with which the school year started, Susan reported success by the end of the year:

> "Well, at [my first school] I was told oh, Ms. X, you're a good teacher, you're a great teacher. And kids would come up, oh, Ms. X, you're the best teacher. ... I was told all that. And I knew that. I knew I was a good teacher ... I worked hard and everything. I gave my students 150 percent. I don't have kids of my own yet. And school was my life. But I still had this kind of doubt. This self-doubt ... [The principal] always said I was great, terrific. My peers did, too. But I had this self-doubt that, am I really a good teacher? Or, really, how good a teacher am I? And so when I took this opportunity to come here, I thought well, I'm really going to find out. Well, anyway when I got this opportunity, I thought this is going to be hard because this is totally different from what I was used to. And I said okay, Susan, you want to find out how good a teacher you are? This is where you're going to

find out. Because the kids aren't going to have the background that they do at [my first school]. Their parents aren't as educated. The value of education might not be as great. The kids aren't going to have the background. Yeah, I knew that coming in. I didn't know how hard it was going to be. But I knew it was going to be hard. And it was going to be challenging. Well, that first year, ... I cried the first three days. ... I went home and told my husband, what have I done? What have I gotten myself into? And, of course, I'm married to a wonderful husband. He knows just what to say when I need it. And he goes Susan, you're a good teacher. You're a great teacher. And he said those kids need you. That's why you're crying. Because you realize how hard you're going to need to work because they need you that much. But you can do it. And he built me up and all this kind of stuff. And I said, you know, you're right. And then [the principal] coming over here, a lot of people said she wasn't going to make it. She wasn't going to make it. And that's the same kind of thing how I felt, too, that I had all these other people that were looking at me and going, she came from [that school]. She's going to sink big time. She's going to fall on her feet. And I just went, I'm not going to let that happen. I'm not going to let that happen. And one, I don't fail anything I do...unless it's just really, really bad. ... When I undertake something, I do it 150 percent. And I'm not going to fail at it. I'm going to do my very best. So after I got through my initial, oh, feeling sorry for myself and what I'd done, then I said okay, I'm going to make this work. And at the end of the year, after all that work, I had never felt so proud of myself on that last day of school."

"We were having an inservice type thing for the last day. [The principal] went around and was asking everybody what was their greatest accomplishment. What did they feel? And, of course, I was last. From where I was sitting, I ended up being last. But I told her—at the time I had gotten through reading... *On the Top* ... It was the account of them trying to go up Mount Everest and the terrible accident that happened and all that kind of stuff. And I had seen it the year before at the I-Max. And I was totally intrigued by somebody trying to climb this and having to acclimatize as they go up, what, 20,000 feet. And oxygen masks and the wind. And the I-Max movie was just incredible. It just showed everything, the frost on their beards. And you're going why would anybody do this? Just to climb a mountain. But at the end, when [the principal] was asking us, I told her, I said that's how I felt. That I had climbed a mountain. I had climbed Mount Everest, 29,000 feet in this one year with everything that I had done. And seeing the kids walk out that last day of school crying because they didn't want to go. And people coming up and going, bye, Ms. X, I don't want to go. And have a nice summer. And all that kind of stuff. I just felt I did it. I had succeeded. And the other thing was to see how much growth they had. I had second graders that year that entered on a first-grade reading level. A first-grade reading level at the beginning of second grade. And at the end of the year, those kids were, if they weren't on grade level which means going into third grade, they were close to it. They were like a 2.5. So they had made over a year's growth, a year and a half practically. A lot of my kids. And I took credit for that. Because I know, their parents as hard as they work and stuff, a lot of them didn't work with their kids at home on school. And so I knew I could take credit for that. That I was the one in the classroom, that the seven hours they were here with me, I was the one that was doing that. I was the one that was making a difference. And that's what really made me feel good. And I knew at the

end of that year, Susan, you're a great teacher, you really are, because you made the difference in these kids' lives ... And before, like I said, I knew that. But I always thought the kids could learn in spite of me. No matter what, they were going to learn. But these kids, I realize that I was the one making the influence on them. And that really made me feel good. And I knew that's why I was supposed to come here.

"Just the challenge of doing something different. And change is hard. At one point, exciting, but when you start doing it, you're like oh, did I do the right thing? Did I do the right thing? And I doubted myself that whole first year. But as the year went on, I got better and better and better. And at the end of the year when I felt so proud of myself, I knew I had done the right thing. And I grew as a professional and personally from that change."

The Second Year

Changing circumstances. During her second year of teaching at the new elementary school, Susan had to change from teaching second grade to teaching first grade, a change made only two weeks before school started. A first grade teacher had resigned and the principal talked with Susan about who should teach first grade:

"[The principal] said she had a first-grade opening two weeks before school started ... She started telling me how she wanted to move people around. She didn't come out and say Susan, would you go to first grade? But I've been working with [her] long enough that I know and I just kind of said well, ... would you like me to go to first grade. She goes, would you ...? I said yeah, because I really do like second grade, but I said yes. I thought about it and thought well, that'll be one more year experience in another grade level and then I will have covered all the primary. So if I ever do leave and go somewhere else, I'll have all this primary experience in third, second, and first. And so I did. And it was an experience because I'd never taught first grade before."

Although Susan was an experienced primary teacher, teaching first grade was a lot different from teaching second or third grade:

"The one thing that was really hard about last year was that I didn't have a lot of first-grade level material..., so I had to make all those charts. Practically every weekend I was making charts. And just coming up with age-appropriate materials for first grade ... I had kind of done some of that at the beginning of second grade because when I saw those kids coming in and they were at a first-grade level, I made some of that stuff. Still, some of the things I didn't have so I had to make [them]. But that was the only thing that was really hard. My class was beautiful."

Organizing for instruction. Susan described the learning centers in her classroom. The previous year she had used eight learning centers; this year she had twelve. Each of the centers had activities that were capable of being done by students individually, but Susan said:

"Granted I'd like for all the kids to be at a center with somebody. Because that just makes that collaboration better. But the centers can all be done by

themselves. I have like the magnetic center. They can look at something and then just match it up. I mean, it'd be nice if somebody were there to say spell the word pig and that person would spell pig. Spell the word cat. And at the listening center, you're listening, looking at the story. Granted, it's more fun to read with somebody else. And at the computers, it's more fun to be looking on at the next computer and see what somebody's doing. But I mean, just the way I've pulled the groups, some people will be with people and some people won't. So I'm still kind of working through that. But you have to have enough centers."

In addition to the standard independent reading center and whole group reading center, Susan also has math centers with manipulatives such as pattern blocks, and the computer center, whose activity changes based on the unit. She also set up a number of language arts centers, for example:

Magnetic center – Plastic letters of the alphabet with magnets on the back, stuck to the radiator. Students form spelling words or sentences from the letters.
Listening center – Tape players with headphones and cassettes of books along with the print book. Students listen to the story with the headphones and tape player as they read the book. After listening, students respond to the story in pictures and writing.
Environmental print center – Cardboard cereal boxes, pages from magazines and other household print products with text and pictures. Students identify letters and later read the print.
Pocket chart center – A chart with a number of clear pockets which hold words to make sentences. Students independently practice making sentences, after the class has done some together.
Point chart – On a chart stand is a poem or story each week. The class reads it together led by the teacher pointing at each word as it is read. Students independently practice reading the poem or story. A variety of creative, teacher-made pointers made with a dowel rod and an object at the end for pointing are at this center. Some creative ends are a heart, a rubber fingertip, a rubber hand, an arrow, a glittery fish, a plastic frog and a smiley face.

Susan reported that spending a part of each day at learning centers is a good way for her students to learn:

"I think this is very good for the kids. One, because it gets them up out of their seats. They're moving around. They're doing more hands-on. Plus they're being forced to be independent. When I'm working with that small reading group, ... and I say I can't be bothered because this is that group's time. If you come across a problem, you need to go find somebody else to help you with this or you need to wait till I'm finished or whatever. So I think it puts a little bit more responsibility on them for their own learning and for problem solving and all of that. And it works real well for this group. Now I'd love the opportunity to go back to [my other school] situation and try this same scenario and see what happens there. But I can't compare the two because I haven't done it with one. I can tell you right now, doing what I did at [my other school] over at [this school] would not work because it was more traditional, kids sitting in their seats, having seat work, doing more large discussion. I don't think that would work

here. I don't think it would work. They need to be up and about. I see good learning going on."

Using technology in the classroom. Susan reported that the computer is an important part of her teaching:

> Having the four computers has made it much easier to get the kids involved with computers. Having access to more software. First grade ordered about $1,000 worth of software ... reading-related, writing-related, math-related. Everything. It was really neat. We got some really good deals. And ... being forced to make the computer center that the kids would have to go work on, and having the four computers, the kids pretty much on average get to go to the computers twice a week for a good 15-30 minutes at a time. Plus they have access to it throughout the day. If they finish with something, it's like Ms. X, can I go work on the computer? Sure. You're finished with your work. And it would stimulate the others to try to get their work finished. And wanting to go on the computers. And we'd take turns. Okay, you've been on the computer enough. Let this person on. So I feel like the computers are being used more which is great, because I've got four. I'd hate for them to be sitting here empty. And, of course, I'm using it as a tool. And learning as well. When we put the alphabet together ... we put that into a Hyper Studio. I've done a slide show in Kid Pix before, but I'd never done Hyper Studio. I've seen it before and I'd taken little classes. But I hadn't actually put a whole one all together. And just being involved with the SEDL thing. Learning how to videotape from the computer to the TV. I thought that was so cool. And just learning the things that we learn from that. I just feel like my technology knowledge has grown since being [here] compared to [her previous school] which ... is ironic."

> "We got a lot of Sunburst [software] that was really good ... I really like the language arts related software ... There was one where the kids ... dragged the word and they could make like a little jump rope vine. It was so fun because we got the earphones and the kids had to put the earphones on. And I would be doing the reading and all of a sudden you'd hear jump, jump, jump, all the way to 10. Jump, jump, jump, never fall down. And they were over there reading and somebody would go and tap them and they'd go "shhhh." But it was just so neat to see them involved, to see them get involved. They were hearing it, reading it, and the software was so neat. It had a variety of things on there. A variety of levels that the kids could work at. Just putting words together with pictures. There was one on phonics where the kids could go and pull letters. And it would say what sound the letter makes ... And we got it mid-way through the year. So I used it kind of late but, and I'm so excited about using it first thing. I know exactly which one I'm going to put on where. And we got a couple of software programs that have to do with math and the kids love that. There was one that had to do with measurement, coins, time ... Oh, like reading tables and graphs, stuff like that, which is really neat. And the kids love it. And they got on. It was more, I guess, drill and practice type stuff. But it was something that the kids could get on and they were very attractive. Very colorful. Very animated. And I was hardly ever, ever bothered. And I knew, every time I'd see that the kids would hate to get off ... There were a couple that were just real hard. I mean, it said for primary but

to me it just seemed like they were too hard for first grade. They were writing ones where the kids had to type. And at first grade, the kids just don't have that typing, they don't have the motor skills yet to type ... And Kid Pix, I showed them how they could get a typewriter and they could type their little thing. And that was pretty good. But like I said, there were a couple of softwares, it was called Beginning Writing, but it was hard. So I don't think we'll use that one. But everything else. We ordered about ten or eleven different softwares. And I think with only two being bad, I didn't think that was too bad."

"Well, I guess, I want to say that the computers lend themselves real well to the kids sharing and wanting to work together ... They're ... more susceptible to oh, come here, I want to show you this. Look at what I made on the computer. They're more eager to share their work ... They constantly want to get on the computer ... [One teacher] said she was worried when we ordered the earphones, whether that was going to be a problem with the kids not sharing ... The kids still have on the earphones and ... they'll still tap each other. And having them side by side like that, they'll still tap and say, hey, look what I did ... During the smaller groups I'll pick out a couple of kids that are just dynamite at the computer. And I've told the kids, I'll announce in the class, so-and-so, Caleb and Robbie are our technology experts. If you have a problem, you might want to ask them first. And so it's given responsibility to those kids. And then they have to go over to Caleb. Caleb, come over here and help me."

Susan used the computer to reinforce what she was doing in class. All of her centers supported what she did with the whole class and with the small groups she worked with. With more software resources, next school year, Susan planned to use specific computer software for specific units. At the beginning of the year, she reported, she will use the basic addition and subtraction software and the basic reading software with phonics, beginning letter sounds, vowel sounds, ending sounds, and clusters. When they do a lesson on money she will use the money software.This past year she really liked the Living Books software, also. Susan said:

"It's a story and it's on the computer. The kids loved it. Oh, you should have seen them. They were like wow, and it was interactive but yet they were reading the story. And it was neat because I'd get the book and I'd make the book accessible in the reading center. So here they'd go to the computer, they'd be able to read it on the computer or listen to it or whatever, follow it along, and then when they went to the reading center they went oh, that was the book, we read that. Because we had *Stella Luna* to go with the bats. So here it was, they were actually able to pick up the book and flip the pages and that was neat."

Designing instructional activities. Susan described some of her activities for her first unit of the year using the school wide theme of communities:

"First grade, we were going to talk about our school community at the beginning of the year. It lends itself very well to that. Learning the rules, responsibility, how we're going to act in school, ... why do we have rules ... Teaching your government, your school community. Basic number recognition, all that beginning school stuff in math. And in reading we were going to look at the alphabet,

concepts of directionality ... And all my poems and charts and big book stories and reading, all centered around school. Everything was a school theme. My read-aloud was "Wayside Stories" from *Wayside School*. It's one of my favorite books. Just hilarious. And it's a school, it's a really wacky school. And each chapter is about one of the kids. And the kids are hilarious. I love reading this to the kids because the kids identify. Oh, look how they act. They're so silly. It's just a great read-aloud ... I'd bring in other books about schools around the world so that we could see differences there."

"Charts that have to do with school things. Colors, numbers, traditional "Twinkle, Twinkle Little Star." That's the tune, but it's a song about colors or numbers or something like that. So it brings in some familiarity. And the kids go oh, that's "Twinkle, Twinkle Little Star." And I'm like yeah, it is. But we're going to sing it with colors or whatever. So that's how we're getting in our concepts. We're learning directionality. I'm using my pointer to show we go from left to right, top to bottom ... that there's spaces in between words. The letters make sounds. The sounds together make words. Things like that. And then in math ... I try to pick out things that have to do with school. How did you get to school? Did you get to school by walking, riding a bike, riding a car, riding a bus? We'll make a graph of that, we'll talk about it. Look, more people came on the bus than on the car. Which way was the least? And they'll say oh, we only had one person walk. So that's how we get in our graphing concepts or math concepts. We'll count how many people are going to eat in the lunchroom, how many brought their lunch, things like that. We'll do calendar. We'll start counting to the 100th day of school, stuff like that."

The principal required each team to meet to align their grade level reading and writing curriculum with the TAAS and the TEKS. Susan had a specific skill or concept she needed to teach each week based on the TEKS. That skill was probably repeated many times during the school year, but for one week it was the emphasis. Susan shared the example of learning directionality. For one week, that concept was the focus, but throughout the year, she constantly reviewed with students about where they wrote their name on a paper, where they started writing on a paper, and where they started reading a book. This review reinforced the concept of directionality many times.

Susan assessed her students' learning in many ways. One is by teacher observation. Once she had taught them something, if she saw they were able to apply it to another situation, without asking for assistance, she perceived that they learned it. An example of her observing student learning was when she watched her students while writing. She taught students to put their finger in between words to allow for spacing. When she walked around the room while they were writing and saw them put a finger in between words, just as she modeled it, Susan reported that they had learned that concept. Another strategy was a paper and pencil task where the explicit purpose was assessment. And less formally, she noted when students told her they had learned something, or when, later in the year, they recalled something learned earlier in the year.

Teaching children to read in first grade, Susan saw tremendous growth in their reading ability:

> "From the beginning of the year, I had kids that were on a level three. They were reading "I can see a red bird," turn the page. "I can see a black cat." "I can see a blue bird." "I can see a yellow train." "I can see a gray boat." ... At the end of the year, they were reading these longer texts ... putting expression in it ... I could see growth from the beginning of the year to the end of the year."

Susan reported that one of the best units of the year was a bat unit, a part of the school-wide migration theme. She reported being surprised by the amount of learning that occurred in that unit, and her students' capability for recall:

> "I do a KWL chart. And we recorded, ... What did they think they knew? [for the K — know] I didn't say that was wrong, no, that was right. I wrote down everything that they said. They said bats drink blood. And bats are vampires ... And we did the W, what do you want to know? And they came up with great questions. I wrote down every single question that they came up with. And, again, you don't say that's a bad question or that's a good question. You write down every question. And then what do we do? We start delving into the study of bats. And at the end, it's like what did we learn? That's the L. And so what do I do? We sit down and we bring out these charts again ... Boys and girls, tell me what you learned. And I start writing down everything that they learned. And it's amazing ... We filled up what we knew about bats. It was one long chart, tablet paper. And it almost went to the bottom. And our questions went almost to the bottom, again. Well, what we learned, we filled up two sheets. And that was really neat. I was like golly, this is great. Look at all the stuff."

> "Oh, the kids come back and say, oh, Ms. X, look, because when I was recording what we learned, we went ahead and went back. And before we did that, we reviewed this is what we knew. And the kids said right away, oh, Ms. X, bats aren't vampires. We went and wrote it down. And when we wrote it, we said bats are not vampires to correct that. And the same thing, yes, bats drink blood but it's blood of certain animals only. They don't drink people's blood. Because I think that's what the kids say. Bats drink people's blood. Bite their necks and no, they don't. We learned that they don't bite people and drink their blood. They bite the animals, though. We read that in a book that ... there were certain bats that would go down and bite cows. And drink their blood. And we learned different kinds of bats. We learned what echo location is. We learned what the different micro and macro bats are. And I mean, just a ton of stuff. Two pages."

Susan had never used the KWL strategy at her previous school. She said:

> "Because I just got set in that certain way. Yeah, I was familiar with KWL charts before. But for whatever reason, I don't know. I never did it that way. And I've seen it as a valuable tool. That really opened my eyes."

Susan had high expectations for her students, and she wanted them to have high expectations for themselves. Every day they began class with an action song whose message was to be the best you can be. Each child stood by her or his seat and recited the song, with actions, while Susan stood in front of the room and led the class. To help students have high expectations for themselves and understand the importance of

school, Susan explicitly discussed with her students every week why they needed to learn to read. She asked her students, "Why do we have to learn how to read?" They gave responses like, "It's a part of our life," "You've got to read the road signs while driving," "When you go to a restaurant you have to read to know what to order, and how much it costs." Susan also explained that they need to read to fill in a job application. One day they branched into a conversation about what they wanted to be when they grow up:

> "And one day we were talking about what we wanted to do when we grew up or something like that and I was telling the kids you can be lawyers or doctors, engineers, architects. And I said, you know what architects are? They build buildings and things like this. I remember one little girl my first year … turned around and she said you know what I want to be, Ms. X? And I said what? And she said, 'When I grow up, I'm going to go get a job and I'm going to be working at Wal-Mart.' And not that that's bad … we have to have people that work at Wal-Mart. But for her to realize that that's … the highest that she wanted to be was a cashier. I mean, that's fine when you're a teenager or you're working your way through college, whatever. That's fine. But for her to realize that was her final—it just upset me. It really did. And when I told that to somebody, they said well, Susan, that's what they're familiar with. They go to Wal-Mart, they see how fun it is. They're doing the cash register and ringing up that stuff. They said that's okay. And I said no, it's not okay … And so I told the little girl, well, that's fine, sweetie, if you want to do that. But wouldn't you want to make a lot more money and wouldn't you—which probably I'm setting them up to be more material-oriented. But I just wanted her to see that there was … and I tell the kids that, you can be a scientist, a doctor, a lawyer, a teacher, whatever. … but I just tell them that all the time, that if they want to be a doctor, they can be a doctor. If they want to be a veterinarian, they can be a vet. If they love animals. I tell them, you know there's a doctor that takes care of animals? You know what that's called? A veterinarian. And they're like wow. And there's people that go dig fossils and that's what their job is. And the kids are like cool. I mean, some of them don't know that there are those jobs out there. So it's kind of like exposing them to that."

> "I honestly believe that you can do anything, you can be anything you want to so long as you try. And I constantly tell the kids that. And I have that on one of my banners … it says you never know what you can do until you try. And I tell the kids all the time that they're special, they can do, they can be anything they want to be but they have to try. And I tell them how did Michael Jordan become a great basketball player? I always try to give them an analogy or something. Do you think that he just one day woke up and decided I'm going to be the greatest basketball player there ever was? And the kids all go, No. They're smart. And I said well, how do you think he got to be so good? And they're smart. They'll tell me he practiced. And I said okay, do you think maybe he practiced like just on Sunday? And they go no, Ms. X, he practiced every day. And I said you got it. He practiced every day for hours and hours and hours. And I said it's the same thing. If you ever see like the gymnast, and I talk about them and anybody on TV, I said how do you think they became so good or somebody playing the piano or something. I said they have to practice and practice. I said it's the same thing with the reading. How do you think you become a better reader? You have to practice

every day. And I tell them about my own experience. I say boys and girls, I carry a book with me everywhere I go … I have one in the car and sometimes I do bad things, like sometimes when I'm in traffic and the traffic's moving real slow or I'm at a stop sign or a stop light, I say I get my book out and I try to read a little bit. And I said then when the green light comes on, I put the book away and I keep driving. And the kids laugh. They think that's funny. But I'm showing them, or I tell them that when I have to go somewhere and I'm having to wait. I say have you all ever gone to the doctor and you had to wait. And the kids go oh yeah, yeah. And they say oh, they've got games there that you can play. And I say well, you know what I do, I read a book. I say I always take a book with me and I read. They have to be modeled that. They have to see it."

In Susan's first year lesson plan for the ATRL project, her second grade class paired with the first grade class in her vertical team. In the second year, Susan's first grade class worked with the fifth grade class in her vertical team on a weekly activity. Susan reported that this collaborative atmosphere was encouraged by the principal.

> She breeds that kind of environment where you help each other … And when I came [here] and went to other people, oh, can I help you, … setting up the room or materials …. They were like where did you all come from? The schools that they came from, people didn't help each other. And it was totally new to them. It was like, 'I've never been at a school where people went in and shared materials with each other.' … We're so used to that now. But before you never shared your stuff with other people."

> "There isn't that competitiveness as much, there was a little bit of competitiveness at [the other school] because we were all at the same grade level. And even though we had different ability groups, you still wanted to have, when you saw somebody doing this, you wanted to do your own thing like that too. And kind of get recognition. But here I don't see that competition. And I don't know if it's because of the vertical teaming or because there's nobody else in my hallway that's first grade."

In January of the second year, Susan began a new weekly activity. Working with the fifth grade teacher and her class in the vertical team, she began a weekly "Reading Buddies" activity. The two teachers scheduled a time each Friday for pairs of first grade and fifth grade students to read to each other. The teachers planned a getting to know each other activity, and discussed expectations with the whole group. Then each week, half of the students met in the fifth grade classroom and half met in the first grade classroom, to read. [See a videotape of this activity in the ATRL video portfolio.] Each fifth grade student also made occasional journal entries about working with their first grade buddy. Midway through the school year, another vertical team in the school began a similar activity.

Susan and the fifth grade teacher decided to branch out with the reading buddies, and to have the students do a project using the computer. This project was Susan's second and final ATRL lesson plan. The overview of the lesson states:

"Students work together in multi-age pairs to design a Kid Pix picture about a letter of the alphabet, that will be put together by the teachers in a HyperStudio stack."

Susan described her Instructional Strategies as follows:

"Project based (KidPix illustration and HyperStudio Stack), students are grouped in 1st and 5th pairs, pre-planning on paper, teacher directed learning, peer instruction, classroom computer time."

The procedure for creating the slide show was described as follows:

- Teachers explain lesson objective and set expectations for student learning.
- Teachers divide each class to create a balance of first and fifth grade students in each teacher room.
- Teachers pass out materials for students to use.
- Teachers circulate and assist student pairs during the lesson.
- Student pairs randomly draw a letter(s)to write and illustrate.
- Student pairs brainstorm a list of vocabulary to represent the chosen alphabet letter.
- Student pairs select three vocabulary words that best represent the letter and the school.
- Student pairs illustrate each chosen vocabulary word.
- Student pairs write a sentence using the three selected words.
- Student pairs transform work on paper to a Kid Pix document.
- Teachers compile student work into a HyperStudio stack.

When Susan was asked to reflect on this activity in relation to one of the principles of constructivism, *Social interaction introduces multiple perspectives through reflection, collaboration, negotiation, and shared meaning*, she stated:

"The students were able to work with someone from another class who was either younger or older than they were. They were able to share ideas and learn from each other."

Susan described the reactions to the unit:

"We are still working on this unit at the time of this reflection. However, the first grade students are having a great time working with their fifth grade buddy. They are most eager to work on the computer. Ms. Y and I will definitely need to plan more collaborative work between the student pairs on the computer. I am most pleased as to how helpful , patient and considerate the fifth grader is to their younger partner. It is also wonderful to see the first grader looking up to the fifth grader as role models. I am very proud of the student learning taking place with this unit /lesson plan."

Comments made by students included the following:

" This is fun!" "I like Kid Pix. You can make lots of stuff on it." "Mrs. X, my buddy showed me how to type the words." " We worked together. I did the drawings and my buddy typed the words."

Final observation. Susan's final classroom observation took place in the spring of the second year of the ATRL project. It was on a Friday morning, when the first and fifth grade buddies were going to be together. The teacher organized the students and sent some to the fifth grade classroom, while some fifth graders came to the first grade classroom. The first graders who went to the fifth grade room took a book to read and their homework folder. Because of absences, some groups included two first graders and one fifth grader. Students read to each other first. In all groups the students took turns reading out loud to each other. Then they made sure the first graders' language arts worksheet was finished. When that was done, students did various activities. Some student pairs went to a computer and read a Living Book such as the *Berenstain Bears*, or *Just Grandma and Me* or used the Jumpstart First Grade software. A pair of students was making designs with the pattern blocks and three students worked at the letter blocks to make words. The students were all engaged and on task. The teacher observed student learning, and prepared for the next lesson. She did not appear to need to supervise student behavior.

Looking Back, Looking Ahead

On her final technology skills self assessment for SEDL, completed in the spring of the second year, Susan marked herself as having gained more experience in spreadsheet skills and using a web browser. Out of 86 skills, 15 were marked as "some experience" and 71 were marked as "experienced."

Susan reflected upon her first year of teaching first grade:

> "And everything worked out ... I had a fabulous year. My class was great. They worked so hard ... And I knew that we as a school had made a difference because my first graders last year were right where they needed to be compared to my second graders. So I knew that the kindergarten teacher before me, the school was making a difference. And that was nice, too, because the kids were familiar with the rules. So I knew things were going to get easier."

Susan described some of her goals over the next few years:

> "Well, I'd just kind of like to keep the same thing and just keep building on it. I'd like to have six computers in my room and that way I could have two for reading and two for math and two for science. There'd be a science center right there. Or split them, one science and one social studies."

She noted that she would like to use the Internet more with her students. She has not done that, because of the possibility of students going to an inappropriate site. She said:

> "And that's another thing I'm kind of wary about because I feel like I need to be right there because there's so much stuff out there ... You type in something wrong and it can lead you off to another site."

She noted that she plans to connect the TV to a computer, and show the students specific Internet sites, and preview software programs as a whole class. The 2nd grade teacher in the room next to hers, who is in her vertical team, used the Internet that way last year, and Susan thought it was a good idea. She was in the process of getting the cabling to be connect the two machines.

Susan stated that she would like to expand in the sciences. She bought a book called *Discovery Boxes*, which had ideas for a science center with science discover boxes. With this approach, the students explore questions and do mini-experiments with simple things like soil. The school had magnifying glasses and microscopes which Susan coul use:

> "I like thinking up new centers. ... So I'm going to see if I can kind of expand on my science area. Because it seemed like last year I focused more on reading. This year with Investigations I want to focus more on math and incorporate the new Investigations unit. That and reading are my favorite. I'm not really into science and social studies, unfortunately, but I'm going there. I see that as a weakness and... I'm going to set that up and then we'll see about social studies."

Although Susan noted that she feels she needs to teach more science and social studies, she said she knows students will get that at a later grade. As a first grade teacher, her main responsibility was to teach students how to read:

> "So I'm not too worried about the science and social studies. I'm going to incorporate it in my reading and writing and stuff like that, but reading and math are going to be my priorities. But I feel real good about where my room is right now. I'm real pleased with it. Like I said, I'm just trying to figure out what's best, what are the best centers I can really do to get the kids to think and be more independent learners. And I just see myself teaching, I guess, keep on doing what I'm doing."

Susan used to prefer teaching math, but since teaching at her current school she said she has changed:

> "But in the last two years I've really developed a better love for reading. I always loved to read. But even now, I even love to teach reading. Because before I was teaching skills. I was teaching the kids how to analyze the books, how to discuss what they were reading, and how to predict and all that stuff. But here I'm actually teaching the reading process and so that's what's really neat ... I'm real into the literacy, the Balanced Literacy. The Guided Reading and all that, doing the centers, has really gotten me hooked on reading and I've seen ... how important reading is ... I've got very, very few kids who will be below grade level on reading. They just had such a better foundation for reading. And I see how important it is, especially for the low SES and minority kids. I've considered looking into, seriously looking into going back to graduate school and getting, I don't know what, a master's in reading or reading education, something like that. And the need, hearing all the thing about the need for good reading teachers ... I love reading, I love children's books, all of that, so I don't know if I'm being led that way now."

Some teachers plan to move into administration, but Susan said she is not interested in working in administration:

> "I have no desire whatsoever to be in any capacity in administration of education. None whatsoever. So if I leave teaching, it'll be to pursue something on my own, like to further my education and then to go on to something specifically for reading education or something. But I have no desire to be a principal, assistant principal, counselor, anything to do with administration. It's just not worth it, it's just not worth the headache ... But I really do, I really love teaching. I feel like I make a difference and there's just nothing like seeing a kid's face light up when they learn something. So I don't know, I can see myself doing this until I retire."

Discussion and Conclusions: A "Cross Grade Collaboration" Learning Environment Assisted by Technology

Susan's first formal classroom observation indicated that she had a low technology and moderate constructivist classroom. By the second formal observation she had moved to a moderate technology and moderate constructivist classroom. By the end of the ATRL project, Susan's final observation indicated she had a moderate technology, high constructivist classroom.

The type of constructivist learning environment that Susan's classroom represents may be characterized as a "Cross Grade Collaboration" model. Teaching in a school with grades K-5 in the same hall gave Susan many opportunities to have informal conversations with teachers at other grade levels, in addition to the monthly vertical team meetings. To reinforce the vertical teams, the principal required classes from each hall to do a presentation each school year. Each hall had a date and a theme for which the teachers and students planned a presentation for a whole school assembly and later repeated at an evening presentation for parents and community members.

Susan utilized her vertical team to team with teachers and their students at other grade levels for unique learning opportunities and specialized projects. During the first year of the ATRL project, Susan's second grade class worked with a first grade class to create a student-illustrated, school song slide show created with Kid Pix software. This project though short term was successful, and gave Susan the idea to expand on teaming with another teacher the next school year. During the second year of the project, Susan's first grade class met weekly with a fifth grade class during the second semester in the "Reading Buddies" continuous learning activity. The technology project of this group was an alphabet story, school slide show created with Kid Pix and HyperStudio software.

Susan's development of a constructivist learning environment supported by technology is analyzed below. The qualities of a constructivist learning environment supported by technology were identified from the research literature and were incorporated into the observation protocol used by ATRL staff in collecting classroom data.

Teacher role. In her first classroom observation, Susan demonstrated the following characteristics of a constructivist learning environment in working with her students:

- Validates and shows respect.
- Establishes positive rapport with students.
- Inquires about student understanding of issues and concepts.
- Facilitates, models and shares social and cognitive skills.
- Nests instruction within relevant, meaningful and real-world context.
- Seeks elaboration and exploration of students' understanding.

In teaching a lesson to the whole class, Susan had an enthusiastic, but firm manner with her students. She encouraged many students to participate during the whole group writing lesson, and questioned the students, encouraging them to explain their ideas on revising the story. She listened to each child and used terms such as "sweetie" to show her affection for them. The story was developed around a picture of a birthday party, a topic which is relevant to her second grade students.

Later formal and informal observations indicated that Susan also demonstrated these characteristics:

- Acts as facilitator and/or co-learner.
- Elicits student's prior knowledge.
- Asks open-ended questions requiring multiple answers and development of multiple levels of thinking.
- Encourages student autonomy and initiative.

In the second year of the ATRL project, when the fifth graders and first graders worked in pairs, Susan adopted the role of facilitator, after establishing her initial expectations for the class. Susan's first grade students were accustomed to their daily routine of learning centers, in which Susan worked with a small group of students on reading and the remainder of the students worked in pairs or individually at a learning center. Students were accustomed to being independent and responsible for completing their learning activities on a daily basis.

When Susan questioned students individually or in small groups, she persisted with her questions, encouraging students to go beyond their initial response and provide multiple reasons for their ideas and answers.

Student role. In terms of students' roles in the classroom, the initial observation of Susan's classroom revealed the following characteristics:

- Interjects personal experience and understanding.
- Draws upon previous knowledge/experiences to contribute to the learning activity.
- Becomes an explorer, problem-solver or active participant rather than a passive observer.
- Shows evidence of understanding ideas /concepts
- Uses mistakes as valuable learning tools

The roles that students took in Susan's classroom reflected some of the qualities of a constructivist learning environment. In the whole class lesson about how to revise writing, the students were confident in sharing their ideas with the teacher. They drew from their personal background to offer suggestions, and most students appeared

actively engaged. They demonstrated an understanding of the concept of the writing process, having initially done the brainstorming and writing stage. They were eager to offer suggestions for correction to the writing sample on the overhead, and did not appear to worry about giving a "wrong" answer. The main tool was the overhead projector, which only the teacher used to revise student writing, based upon students' input.

Later formal and informal observations indicated that Susan's students also demonstrated these characteristics:

- Uses a variety of both technology and non-technology materials and tools for learning.
- Uses raw data, primary resources, manipulative, or interactive materials requiring interpretation.
- Uses technology to access information that is otherwise unavailable.
- Raises questions for exploration or identifies problems to be solved.
- Designs methods for answering questions or solving their own problems.

Students used many more resources during later observations and in Susan's lesson plans developed for the ATRL project. When students worked in cross grade level pairs on their technology project, they first brainstormed ideas, then made a paper and crayon drawing for their first draft before going to the computer to create their drawing. Students questioned each other, and often answered their own questions, without teacher assistance. When students were not at the computers, they worked in collaborative pairs, reading, and doing activities at the various hands-on centers in the classroom. The first graders in Susan's class were able to do more with technology working with a fifth grader, than they would have been able to do on their own. Fifth graders served as mentors to the first graders, while increasing their own technology skills as well.

Curriculum. In terms of curricular content and instructional strategies, the initial observation revealed the following characteristics:

- Problems are meaningful and relevant to students.
- Stimulates thought and action through interesting, relevant and authentic problems.
- Activities include journaling, questions, and discussion to provide opportunities for reflection.
- Activities focus on developing higher order thinking skills through problem solving and exploration.
- Part of a larger instructional activity that leads to multiple opportunities for learning.

Susan's classroom activities frequently exhibited all of the above indicators of a constructivist curriculum. The writing topic for Susan's first year ATRL lesson was a birthday party, a topic relevant to the second graders. They worked as a group to revise the writing, and discussed the ideas shared by other students. The revising was the continuation of a writing activity begun earlier in the week. Revising written materials is a skill used throughout school and into the work world.

Later formal and informal observations indicated that the curriculum Susan used also demonstrated these characteristics:

- Structured around complex or many faceted themes.
- Provides opportunity for interdisciplinary learning.
- Opportunities are available for self guided exploration.

As the project progressed, Susan appeared to move further toward a constructivist learning environment in her curriculum. She designed activities that were complex and interdisciplinary. When students created their alphabet slide, they could do it on any topic. Students chose math, science, physical education, lunch, people and other topics related to the school. Since the students worked in cross grade collaborative pairs, they relied upon each other for exploration and extending their learning. The fifth graders also learned from the first graders, to respect the ideas and talents of those of a different age. Since the school had thematic units, Susan designed her curriculum in an interdisciplinary manner. When her class did the bat unit for the migration theme, the activities within each subject related to bats.

Classroom. In Susan's first classroom observation, the characteristics of her classroom did not reflect a constructivist learning environment, as outlined in the ATRL project design and observation protocol. However, later formal and informal observations noted the following characteristics:

- Emphasizes the activity of the student rather than the activity of the teacher.
- Opportunities are available for peer collaboration.
- Opportunities are available for cooperative groupings or small group instruction.
- Students are engaged in different activities at different times.

All of the above qualities were evident in Susan's lesson plans as well. In order for the computers to be used by students, and to teach a small group of students reading, Susan designed her classroom with learning centers. When she designed the activities with cross grade collaborative pairs, her students were accustomed to working with a partner and seamlessly made the transition to working with a student from another grade level. Students easily transitioned to the various activities they could do with their reading buddy: read together, learn at a hands-on center, learn at the computer. And various pairs of students did different activities at different times, with the teacher making sure everyone had time at the computers.

Assessment. Within the category of assessment, Susan's initial observation indicated the following characteristic of a constructivist learning environment:

- Uses ongoing assessment that is interwoven with student learning.

As a primary school teacher, Susan's assessment is interwoven with student learning in the writing activity. The primary way Susan assessed her students' learning was through oral interaction with the students.

Later formal and informal observations indicated that Susan's approach to assessment also demonstrated these characteristics:

- Uses multiple ways to assess student learning.
- Students participate in establishing criteria for success/assessment.

As Susan reported in her interviews, she assessed her students in multiple ways. When the students worked in cross grade collaborative pairs, they were assessed not only on their final technology product but on the work that led up to that product and on their ability to work cooperatively with a student at another grade level. When the students presented their final products to the whole class, which is demonstrated in the videotape, *Reading Buddies*, students verbally shared with each other what they liked about a particular slide and why.

School context. Observations, interviews, and results from the *Teaching, Learning, and Computing Survey* indicated that the following school characteristics played a role in Susan's development of a technology-assisted constructivist learning environment:

Administrative support. Susan changed schools, primarily because the principal she worked with and respected changed schools, and asked Susan to come with her. Susan's principal attended most of the ATRL professional development sessions as an observer and supporter. She was an advocate in the district for her school and teachers. All of the teachers at the school had a telephone and at least one computer with Internet access in their classrooms, before other schools in the district had these resources. In the TLC survey Susan noted that she strongly agreed that, "My principal's values and philosophy of education are similar to my own." In an interview, Susan noted:

> "She's such a good administrator, she's just built for that job. ...because she knows exactly what to say. And with all the encouragement, it just makes you want to continue, to keep on doing better. She'll leave a note in your box that says, oh, I went into your room, it looks lovely, it's so bright and cheerful and everything ... You're just appreciated for what you're doing. And you're told you did a great job."

Professional development. The SEDL project provided for 72 hours of professional development over two years. Although Susan was quite skilled with technology when she began the project, she benefited from the integration ideas and collaboration with colleagues that the professional development sessions provided. Susan said, "I see myself using technology a lot more at [this school] than I did at [my old school] considering that [my old school] was—and it's kind of ironic because [my old school] is supposed to be the technology school and everything. But I wasn't into it." Susan also had opportunities to attend many additional professional development sessions on a variety of topics provided through the district in the evenings and during the summer.

Technical support. Susan had sufficient technical support at her campus. A full time technology specialist, who formerly had been a full time classroom teacher, provided the technology support at her campus. In her TLC survey Susan noted that the quality of her technical support was excellent, that technical support was available almost always when she needed it, and that she needed technical support 1 –3 times per month.

Technology access. A major reason Susan used technology more at her new school than her old school was that she had four computers at her new school. At her old school she had only one computer, which she utilized as a teacher tool. Since she taught her class in the traditional way as a whole group, she designed few opportunities for her students to use the computer in the classroom. At her old school, her students used the computer lab at their weekly designated time.

In addition to four computers and a printer, Susan had Internet access the entire time of the project. Susan did not use the Internet with her students, because she was concerned about them accidentally accessing inappropriate sites. The computers at her school were Macintosh G3s with Mac OS 8.1. Software on all computers included ClarisWorks, HyperStudio, KidPix Studio Deluxe, Netscape, Eudora, Story Book Weaver, Filemaker Pro, and JumpStart. In addition, the school maintains copies of Microsoft Office, Adobe PhotoShop, Adobe Illustrator, Adobe Photo Deluxe, and OmniPage Pro. Teachers and students also had the use of eleven laser printers, nine color printers, and two scanners. The second year of the project, Susan's grade level purchased software such as various children's books in the Living Books series, First Grade Phonics, Letter Sounds, Print Explosion and some additional math and reading drill and practice software.

Time for planning and professional development. The district provided three district days for the ATRL professional development and SEDL provided three non salary days such as Saturdays or after school, with stipends for participating teachers. The majority of the ATRL professional development sessions that were not part of the district calendar were scheduled after school from 3 pm – 6 pm.

Susan had one planning period each day. After taking her students to and from the specialist's classroom, this gave her thirty minutes to plan. Susan planned her day-to-day lessons independently of other teachers. The school had broad themes within which she needed to work. As reported, that is another reason she wanted to change schools, to have the freedom to teach how and what she wanted to teach, to meet her students' needs. The vertical and grade level teams met monthly, after school. Teachers did not have many opportunities during the school day to meet, because of their many responsibilities. It would not be uncommon to find Susan working after school until 5 pm or later, after starting her day at school at 7:30 am. The second year of the project, the school received an extra grant that gave the faculty four extra full pay days during the school year. These needed to be on a Saturday or other non salary day, when all of the teachers met at school to plan and work together. Teachers were paid at their full salary level, as opposed to the stipend of $70 that they received for professional development from the ATRL project.

Critical mass of teachers who can collaborate. All of the teachers at the new school participated in the ATRL project. The principal informed teachers during the hiring process that they would be required to participate in the project. The first year there were 31 participants, including all of the preK –fifth grade teachers, the resource specialists and the librarian. The school was not at capacity the first year, and as enrollment increased and new teachers were hired for the second year, only the first – fifth grade teachers were in the ATRL project. This critical mass of teachers contributed to the success of the ATRL project at this school. Teachers appreciated the opportunities to share ideas and learn together during the professional development sessions.

Positive peer support. Many factors at Susan's school led to positive peer support, including the philosophy of the principal, the organization of the school into vertical teams, and the use of school-wide thematic units. Susan appeared to have a good relationship with the teachers in her vertical team, as well as those in her grade level team. Unlike at her previous school, she was not required plan day to day with the other same grade level teachers, yet grade level teachers shared ideas regularly. Susan was often asked for assistance with technology by other teachers on her hall, and she was pleased to help. Colleagues also gave her ideas, like connecting the TV to the computer to show a web site to the whole class.

Susan was the first teacher at her school to initiate cross grade collaboration. After the Reading Buddies project began, another vertical team asked her if they could copy her idea. So another first and fifth grade class met once per week for reading and other activities.

Pressure from external testing. The Texas Assessment of Academic Skills (TAAS) is a test given for the first time in math and language arts at the third grade level. Preparation for this test is a high priority for third through fifth grade students at Susan's school. Since Susan has taught first and second grade, she has been somewhat protected from the emphasis on TAAS.

Personal attributes of the teacher. Susan exhibited a number of personal characteristics that contributed to her establishment of a technology-assisted constructivist learning environment. These include:

Commitment to change. In order for teachers to be hired at Susan's new school, they had to agree to participate in the ATRL project. The interview process was designed so that teachers could explain their philosophy of teaching and learning through surveys, a written response and verbal questions. To be hired, teachers needed to support student centered learning, so the expectation was set for all faculty from the beginning. One reason that Susan changed schools, was so that she could change her classroom environment. Susan was dedicated to change; she transferred from an established school in a wealthy neighborhood to a new school in a low income neighborhood.

Technology skills. Susan was already quite confident using technology when the project began. She increased her skills in presentation, spreadsheet and database software.

Skills in instructional planning and design. Susan took into account the needs of her students as she planned. She noted that she had to adjust her teaching when she first went to the new school, in order to help her students to succeed. As a primary school teacher, Susan's main goal was to teach her students how to read. Her centers were full of print resources for her students to read and experience. Her favorite software was the Living Books, to reinforce her students' reading. In general, her students performed at grade level in reading, as a result of Susan's careful planning and instruction. Susan noted:

> "They've got to have that reading. And that's my job. Come fifth grade, they'll get all that science and government ... What's going to hurt them is when they

> get there and they don't know how to read. So I'm not too worried about the science and social studies. I'm going to incorporate it in my reading and writing, ... but reading and math are going to be my priorities."

Susan's initiation of the cross grade Reading Buddies was to fulfill her goal of improving her student's reading. Each first grader had a one-on-one tutor in a fifth grade mentor each week. Each week the pairs read and did various hands-on activities together.

Philosophy. Susan stated her philosophy that "All children can learn." She used a variety of strategies to help children learn. On the Teaching, Learning, and Computing survey, in a section where teachers can select beliefs about teaching which are either constructivist or traditional, Susan selected the box in the middle of the two philosophies for four of the five descriptions. She used an instructional method that she felt would best meet the needs of her students, sometimes traditional and sometimes constructivist. Many additional responses on the TLC survey indicated a middle ground, also.

Expectations. Susan demonstrated her philosophy that "All children can learn," by taking the risk of changing schools to teach a diverse group of low income students. Her first school was one that many teachers, families and community members would consider the best school in town. It was an award-winning school, with many children of college educated parents who were involved in campus activities. Yet, Susan wasn't satisfied that she was really "teaching" those privileged children. As reported in her interview, she felt that most children at her old school would learn, whether she taught them or not. Susan wanted to really "teach" children. Susan transferred to the new school, where she had high expectations that she could make a difference and help all of her students to learn.

Appendix 8

Case Study Interview Questions

Interview one

Think about your current teaching practice ...

1. How do you go about planning what you will do with your students in the classroom?
2. Tell me about the day to day planning.
3. Tell me about the big picture - a semester – or the whole year.

4. How do you decide how to organize your classroom for learning?
   Describe one of the ways that you organize your classroom.

5. How do you decide what materials to use?
   Describe some of the materials do you use.

6. How do you decide what other resources to use?
   Describe some of the resources you use.

7. Do you change lessons, units, or strategies from semester to semester or year to year?

8. Do you do the same thing in each of your classes?

9. Describe one of your typical classes. Tell me what the students are doing. Tell me what you are doing.
10. What is the hardest part about your teaching?
    What is the part you like least?

11. What is the easiest part about your teaching?
    What is the part you like best?

12. How are you evaluated in your teaching practice?

13. Where do you get support in your day to day teaching?

14. What are the detractors to your teaching?

15. Do you feel successful in your teaching? How do you know?
    What do you think is your strongest attribute ... that you bring to your teaching?

Tell me about your students ...

1. How do you go about planning ... based on your students' different levels, experiences and background?
2. How do your learn about your students experience, background, or home environment?
3. How do you know that your students have learned something?
4. Are your students evaluated by anyone other than your?
5. How do students respond to ..... in your classroom? (maybe the teacher has talked about a special activity or strategy)

6. Describe your students' capabilities.
7. Describe the expectations you have for your students.

Interview two

Think back to when you started teaching

1. How long have you been teaching? Describe your teaching practice at the time that you first started.
2. If you reflect upon your teaching style today, what experiences, both formal and informal influenced your teaching?
   formal = courses, training sessions
   Informal = other people, reading, travel, movies
3. What is your guiding philosophy of education – something that you always think about of keep in mind as you teach?
   How did you develop this philosophy? Has it changed over the years?
4. How has your teaching changed from when you first started teaching?
5. What other schools have you taught in?
6. What other subjects have you taught?
7. What is your favorite subject to teach?
8. Compare your teaching with technology experience last year (98-99) versus this year (99-00).
9. What are some of the important supports or interventions that helped you change your teaching practice over the past two years?
10. What are some of the barriers to your changing teaching practice over the past two years?
11. Why did you participate in the SEDL program?
12. Did participating in the SEDL program help you change? How?
13. How do you see/imagine your classroom practice two years from now?

Interview three

Let's talk about technology ...

1. What technology do you use in your classroom? Hardware and software?

   What technology do you have access to ... beyond your classroom?
   How many computers did you have in your classroom two years ago? How many do you have now?
   How does the number of computers impact what happens in a learner-centered environment?
   What kind of tech support do you have access to?

2. How does your school/district distribute technology resources?

3. Who gets computers in your school? How did you get your computers?

4. What technology has been successful for you? Why do you think so?

5. What technology has **not** been successful for you? Why do you think so?

6. Has using technology changed the way that you plan your teaching?
   How do you manage the technology in the classroom?
   Has having computers in your classroom changed what you do? Explain.
   Would you have been able to change your classroom without technology?
   How has technology changed your curriculum?
   How does the curriculum content influence your ability to use technology in a learner-centered environment?

7. How has technology facilitated the development of a learner-centered environment?

   Has technology changed the way that your students interact with each other? How?

   How do you think that has technology improved the way that students learn?

   Has technology improved the quality of student's work? Explain.

   Do you have any evidence that any of your students have improved their learning through the use of technology in the classroom? Explain.

   Describe your students' capabilities.

   Describe the expectations you have of your students.

8. How would you describe your personal technology skills/comfort level/altitude toward technology?
9. What skills have increased over the past two years?
10. Do you think having more skills will increase the use of technology in your classroom? Explain.
11. How do you see/imagine your classroom practice two years from now?
12. Describe any problem areas in working with technology in a learner-centered environment?
13. What do you see as the strengths/weaknesses of a learner-centered environment supported by technology?

Appendix 9

G5 - Classroom Observation Protocol

Teacher _____ **School** _____

Class/Grade _____ **Date Observed** _____ **Time** _____ **Observer** _____

Classroom Demographics

Total number of students: _____

Gender of teacher: _____

Ethnicity of students: _____

Ethnicity of teacher: _____

Gender of students: _____

Other pertinent demographics: _____

Classroom Environment

Overall appearance: _____

Seating arrangement: _____

Classroom space: _____

Distracters/barriers: _____

Major content area of the lesson or activity

❑ Math ❑ Science ❑ Social Studies ❑ Language Arts ❑ Other

Instruction

What is the intended purpose of this lesson or activity? For example: Identifying prior student knowledge, introducing new concepts, developing conceptual understanding, reviewing concepts, developing problem solving skills, learning processes or procedures, learning isolated facts, developing core ideas, developing student awareness, assessing student achievement.

What classroom resources are being used?

For example: Print materials, hands-on/manipulative materials/models/tools/ technology/audio-visual resources

Describe the major way (s) this lesson was structured.

For example: whole group (entire class together), small groups, pairs, individuals

Indicate the major way in which students engaged in activities.

For example: whole-class same activity, groups of students engaged in same activities at the same time, different groups - different activities

Describe the way the activity (activities) is/are taking place.

For example: Formal presentations by teacher, students presenting work orally, guest speaker, discussions/seminars, whole group led by teacher, whole group led by student (s), groups/pairs, role play, debate, game, fieldwork, building/making things

Describe the purpose of the lesson/activity-taking place.

For example: problem solving, data collection, practice, analysis, review, communication, developing skills, developing concepts.

Describe the use of technology resources.

For example: To develop conceptual understanding, learn or practice a skill, collect data, analysis, create a presentation, reports, publishing, communication (e-mail, Internet, WWW).

Describe forms of assessment being used.

For example: Homework/worksheet review, questioning for understanding, performance based, embedded in activity or project, paper test, oral test, portfolio, other.

Observation synthesis based on Constructivist principles

Teacher: _____ **School:** _____

Class/Grade: _____ **Date Observed:** _____ **Time:** _____ **Observer** _____

Descriptors for observation
Not evident at all
Minimal - may or may not be effective
Sometimes - may or may not be effective
Frequent - effective for learning
Regular practice - effective for learning

I. Learners bring unique prior knowledge, experience, and beliefs to a learning situation.

	Check one that applies				
	Not evident	Minimal	Sometimes	Frequent	Regular Practice
1. This **session** is structured so students can interject relevant personal experiences and understandings.					
2. This **session** is framed so that problems are meaningful and relevant to students.					
3. The **teacher** elicits prior knowledge by encouraging the sharing of experiences.					
4. The **teacher** validates and shows mutual respect for all responses.					
5. The **teacher** inquires about student understanding of issues or concepts before offering his/her own understanding.					
6. The **teacher** nests instruction within relevant, meaningful and real-world context.					
7. The **student** draws upon previous knowledge/experiences to contribute to the learning activity and create new knowledge and understandings.					

II. Knowledge is constructed uniquely and individually, in multiple ways, through a variety of authentic tools, resources, experiences, and contexts.

1. This **session** is structured around complex or many-faceted themes.					
2. This **session** provides opportunity for interdisciplinary exploration.					
3. The **teacher** provides multiple ways of learning.					
4. The **teacher** provides opportunities for students to express ideas/experiences through electronic technologies.					
5. The **student** uses a variety of non-technology materials and tools for learning.					
6. The **student** uses raw data, primary resources, manipulative, or interactive materials requiring interpretation.					
7. The **student** uses technology to access information that is otherwise unavailable.					

Descriptors for observation

Not evident at all
Minimal - may or may not be effective
Sometimes - may or may not be effective
Frequent - effective for learning
Regular practice - effective for learning.

III. Learning is both an active and reflective process.

	Check one that applies				
	Not evident	Minimal	Sometimes	Frequent	Regular practice
1. This **session** emphasizes the activity of the student rather than the activity of the teacher.					
2. The **teacher** stimulates thought and action through interesting, relevant, and authentic problems.					
3. The **student** becomes an explorer, problem-solver or active participant rather than a passive observer.					
4. The **student** reflects upon the task at hand through journaling, questions, or discussion.					

IV. Learning is a developmental process of accommodation, assimilation, or rejection to construct new conceptual structures, meaningful representations, or new mental models.

1. This **session** is part of a larger instructional activity that leads to multiple opportunities for learning.					
2. The **teacher** asks open-ended questions requiring multiple answers and development of multiple levels of thinking.					
3. The **teacher** seeks elaboration and exploration of students' understandings to elicit reflection.					
4. The **teacher** focuses on developing higher order thirking skills through problem solving and exploration activities.					
5. The **teacher** uses on-going assessment that is interwoven with (not discrete from) student learning.					
6. The **teacher** uses multiple ways to assess student product and process.					
7. The **student** recognizes and uses mistakes as valuable learning tools.					
8. The **student** shows evidence of understanding ideas and concepts.					

Descriptors for observation

Not evident at all
Minimal - may or may not be effective
Sometimes - may or may not be effective
Frequent - effective for learning
Regular practice - effective for learning

	Check one that applies				
	Not evident	Minimal	Sometimes	Frequent	Regular practice
V. Social interaction introduces multiple perspectives through reflection, collaboration, negotiation, and shared meaning.					
1. This **session** provides opportunities for students to communicate with members of the larger community through letters, interviews, phone conversations, CMC, etc.					
2. This **session** provides opportunities for peer collaboration through discussion, project work and/or CMC.					
3. The **teacher** provides opportunities for collaborative / cooperative groupings or small group instruction.					
4. The **teacher** facilitates, models, and shares social and cognitive skills.					
5. The **teacher** established a positive rapport with individual students and with the class as a whole					
6. The **teacher** acts as a facilitator and/or co-learner (guide on the side).					
7. The **teacher** allows for students to collaborate with others during learning activities.					
8. **Students** are engaged in different activities at different times.					
VI. Learning is internally controlled and mediated by the learner.					
9. This **session** provides opportunities for self-guided exploration.					
10. The **teacher** encourages student autonomy and initiative.					
11. **Students** raise questions for exploration or identify problems to be solved.					
12. **Students** design methods for answering questions or solving their own problems.					
13. **Students** help determine how their understanding will be demonstrated or assessed.					

Principles of Constructivism - TAP's working definition

1. Learners bring unique prior knowledge, experience, and beliefs to a learning situation.
2. Knowledge is constructed uniquely and individually, in multiple ways, through a variety of authentic tools, resources, experiences, and contexts.
3. Learning is both an active and reflective process.
4. Learning is a developmental process of accommodation, assimilation, or rejection to construct new conceptual structures, meaningful representations, or new mental models.
5. Social interaction introduces multiple perspectives through reflection, collaboration, negotiation, and shared meaning.
6. Learning is internally controlled and mediated by the learner.

Appendix 10

Cross tabulations from the Teaching, Learning, and Computing: Teacher's survey

Items that show major differences

TLC Item	TLC 98	ATRL 00
J1C From which type of class discussion do you think students gain more knowledge Ms Hill = traditional practice Mr. Jones = constructivist practice	Definitely Ms Hill 13.8% Tend toward Ms Hill 30.%% Cannot decide 14.5% Tend toward Mr Jones 29.1% Definitely Mr Jones 12.6%	Definitely Ms Hill 5.8% Tend toward Ms Hill 15.5% Cannot decide 10.7% Tend toward Mr Jones 45.6% Definitely Mr Jones 22.3%
J1D From which type of discussion do you think students gain more useful skills? Ms Hill = traditional practice Mr. Jones = constructivist practice	Definitely Ms Hill 9.9% Tend toward Ms Hill 18.7% Cannot decide 14.0% Tend toward Mr Jones 42.3% Definitely Mr Jones 15.1%	Definitely Ms Hill 5.8% Tend toward Ms Hill 10.7% Cannot decide 4.9% Tend toward Mr Jones 50.5% Definitely Mr Jones 28.2%
J2D teacher not student should decide activities	Strongly disagree 6.9% Moderately disagree 20.3% Slightly disagree 23.1% Slightly agree 23.1% Moderately agree 21.9% Strongly agree 7.6%	Strongly disagree 14.4%% Moderately disagree 26.9% Slightly disagree 28.8% Slightly agree 17.3 Moderately agree 17.3% Strongly agree 0%

TLC Item	TLC 98	ATRL 00
K6E In introducing the current unit I raised questions about the unit	Did not do and rarely do 51.7% Did not use but often do 26.3% Used this time 22.0%	Did not do and rarely do 27.8% Did not use but often do 29.9% Used this time 42.3%
K7A Teacher led a whole-class discussion	Under 30 minutes 33.1% 30-60 minutes 33.5% 1 1/4 to 2 hours 21.1% Over 2 hours 12.3%	Under 30 minutes 60.8% 30-60 minutes 29.9% 1 1/4 to 2 hours 8.2% Over 2 hours 1.0%
K7B Students led a discussion or gave a presentation	Under 30 minutes 52.1% 30-60 minutes 31.6% 1 1/4 to 2 hours 13.3% Over 2 hours 2.9%	Under 30 minutes 37.5% 30-60 minutes 38.5% 1 1/4 to 2 hours 15.6% Over 2 hours 8.3%
K8A How often to students work individually answering questions?	Never 7.7% Sometimes 24.2% 1-3 times per month 15.4% 1-3 times per week 33.8% Almost every day 19.0%	Never 13.3% Sometimes 39.8% 1-3 times per month 13.3% 1-3 times per week 26.5% Almost every day 7.1%

TLC Item	TLC 98	ATRL 00
K8D How often do students write in a journal?	Never 43.4% Sometimes 21.7% 1-3 times per month 7.1% 1-3 times per week 11.4% Almost every day 16.4%	Never 24.0% Sometimes 14.0% 1-3 times per month 7.0% 1-3 times per week 19.0% Almost every day 36.0%
L0 Check the one description of computer use that most describes you (in the class you feel the most successful teaching)		
Use computers in the same class described	60.1%	90.2%

L5A1 mastering skills *(instructional use of technology)* Objective Selected...	TLC 98	ATRL 00
expression in writing	66.6%	81.1%
communicate electronically	24.6%	40.0%
find out about ideas and info	71.4%	84.2%
present info to audience	41.2%	72.6%
improve comp. skills	69.5%	84.2%
learn to work collaboratively	57.9%	83.2%
learn to work independently	72.7%	84.2%

TLC Item	TLC 98	ATRL 00
L10A How long ago did you first use computers to assign computer tasks to students	2 years 31.0%	2 years 47.6%
L16C In last five years, students used computers to write a story with graphics	Partly16.3% Yes 18.7%	Partly25.5% Yes 33.3%
L17A In last five years, trying out new software	MUCH more now 21.7%	MUCH more now 42.2%

L17B In last five years, using computers for class preparation	More frequently now 38.8% MUCH more now 32.8%	More frequently now 46.5% MUCH more now 43.6%
L17C In last five years, using computers for non-work activities	MUCH more now 29.0%	MUCH more now 47.0%
L17D In last five years, assigning students to use computers	MUCH more now 24.3%	MUCH more now 45.1%
L17E In last five years, suggesting that students use computers in their projects	MUCH more now 33.2%	MUCH more now 49.0%

TLC Item	TLC 98	ATRL 00
L0 I use computers in the class where I feel most successful	60.1%	90.2%
L10A How long ago did you first use computers to assign computer tasks to students? – 2 years	31 %	47.6 %
M3C In the past 3 years, I have given a workshop or talk for at least 25 teachers	35.4%	52.9%
M3G In the past 3 years, I have had none of those (professional) experiences	40.2%	23.1%
M4A7Compared to 3 years ago, I have evaluated students through products vs tests.	More now 38.7 MUCH more now 15.1%	More now 45.2% MUCH more now 22.1%
M4A8 Compared to 3 years ago, I have allowed myself to be taught by students.	MUCH more now 13.7%	MUCH More now 30.8%
M4B How much of a role have computers played in making changes in teaching?	Substantial role 21.6% Major role 6.1%	Substantial role 39.8 Major role 20.4
M5A1 Compared to 3 years ago, students teach or help other students.	More now 40.8%	More now 53.4%
M5A2 Compared to 3 years ago, students explore a topic on their own	More now 44.6% MUCH more now 8.8%	More now 40.8% MUCH more now 21.4%

M5A3 Compared to 3 years ago, students review and revise their own work	More now 42.8% MUCH more now 15.8%	More now 54.4% MUCH more now 20.4 %
M5B How much of a role have computers played in changes to student assignments?	Substantial role 22.8% Major role 6.1% Total 28.9%	Substantial role 44.9% Major role 18.4% Total 63.3%
M6A1 Compared to 3 years ago, I work with other teachers on curriculum planning	More now 28.2% MUCH more now 15.1%	More now 37.9% MUCH more now 28.2%
M6A2 Compared to 3 years ago, I talk with other teachers about teaching strategies	More now 38.1% MUCH more now 15.8%	More now 46.6% MUCH more now 31.1%
M6B How much of a role have computers played in changes in your teaching practice? *Working with other teachers, talking with other teachers about teaching strategies, spend time preparing lessons, reflect about good teaching.*	Substantial role 19.8% Major role 5.5%	Substantial role 45.9% Major role 11.2%
M7A Computers affect the way you organize space in your classroom	Big change 12.7%	Big change 30.1%
M7B Computers affect the way you break up your class period into activities.	Moderate change 16.0% Big change 8.25	Moderate change 38.8% Big change 21.4%
M7C Computers affect your beliefs about curriculum priorities	Moderate change 20.4% Big change 7.1%	Moderate change 36.9% Big change 17.5%

M7D Computers affect your goals in teaching	Moderate change 25.0% Big change 7.9%	Moderate change 38.8% Big change 15.5%
M8E Staff development/workshops taken influenced your teaching practice	Moderate reason 39.6% Major reason 14.5%	Moderate reason 42.7% Major reason 34.1%
M8F Discussions with colleagues at school influenced your teaching practice	Moderate reason 37.7% Major reason 7.8%	Major reason 48.5% Major reason 13.6%
M8H Changes in main goals for your students influenced your teaching practice	Moderate reason 41.5% Major reason 14.9%	Moderate reason 49.5% Major reason 19.4%
M8I Changes in your understanding of learning influenced your teaching practice	Moderate reason 39.8% Major reason 14.2%	Moderate reason 47.6% Major reason 25.2%
M8K Computer/technology opportunity and experience influenced your teaching practice	Moderate reason 35.9% Major reason 14.8%	Moderate reason 37.9% Major reason 40.8%

N2A Since September, have had contact with others through a workshop, class, confereence	3-5 times 29.4% More often 12.6%	3-5 times 40.2% More often 19.6%

N2C Since September, have had contact with others through electronic mail	3-5 times 9.2% More often 15.5%	3-5 times 22.5% More often 32.4%
N3C The people who give me the best teaching ideas know a lot about computers	Moderately agree 14.2% Strongly agree 7.0	Moderately agree 30.4% Strongly agree 18.6%
N3J It is common for us to share samples of student work	Moderately agree 28.6% Strongly agree 15.1%	Moderately agree 40.8% Strongly agree 24.3%
N5B Formal staff development topic – [re:] New knowledge about subject-matter	Topic mentioned 30.9% Central topic 26.1%	Topic mentioned 41.2% Central topic 35.3%
N5C Formal staff development topic – [re:] Improving student group/peer work	Topic mentioned 46.0% Central topic 17.1%	Topic mentioned 50.% Central topic 34.6%
N5D Formal staff development topic [re:] Computer technology/software mechanics	Central topic 40.9%	Central topic 76.9%
N5E Formal staff development topic - [re:] Integrating computers into instruction	Central topic 32.7%	Central topic 78.6%
N5F Formal staff development topic – [re:[How to use the Internet/other on-line work	Central topic 30.3%	Central topic 68.8%
N5G Formal staff development topic – [re:] Enabling students to do multimedia work	Central topic 12.1%	Central topic 67.0%
N5H Formal staff development topic – [re:] Connecting skills with real-world	Topic mentioned 46.3% Central topic 15.6%	Topic mentioned 53.8% Central topic 38.5%
N5I Formal staff development topic – [re:] Connecting content with student interests	Topic mentioned 44.2% Central topic 10.5%	Topic mentioned 54.8% Central topic 34.6%
N5J Formal staff development topic – [re] Improving student critical thinking	Central topic 27.6%	Central topic 53.4%

N5K Formal staff development topic – [re:] Improving student meta-cognition	Topic mentioned 37.5% Central topic 12.1%	Topic mentioned 55.8% Central topic 20.2%
N5L Formal staff development topic - Improving student ability to write/review	Topic mentioned 36.2% Central topic 23.2%	Topic mentioned 40.4% Central topic 38.5%
N6F The school has provided a computer printer in your room or nearby	Yes 77.8%	Yes 98.1%
N6H The school has provided access to e-mail from class, lounge, or office	Yes 51.9%	Yes 97.1%
N6I The school has provided modem access to the Internet from class	Yes 31.3%	Yes 76.0%
N6J The school has provided high speed access to the Internet from class	Yes 25.6%	Yes 71.2%
N6L The school has provided access to the schools computer network from home	Yes 11.8%	Yes 26.9%
N6M The school has provided access to the Internet from home through district	Yes 18.8%	Yes 27.0%
N8C1 Quality of technical support	Excellent 10.5%	Excellent 26.9%
N8C2 Quality of instructional support	Good 25.4 Very Good 12.4% Excellent 7.1%	Good 29.8 Very Good 19.2% Excellent 17.3%

end

Appendix 11

Teaching Learning, and Computing: 1998

A National Survey of Schools and Teachers
Describing Their Best Practices, Teaching Philosophies, and Uses of Technology

Teacher's Survey: Combined Versions 1-4

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and
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Principal Investigators

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Study Endorsers:

National Association of Elementary School Principals (NAESP)
National Association of Secondary School Principals (NASSP)
Association for Supervision and Curriculum Development (ASCD)
American Association of School Administrators (AASA)
National Catholic Educational Association (NCEA)
National School Boards Association (NSBA)
Council of Chief State School Officers (CCSSO)
National Education Association (NEA)
American Federation of Teachers (AFT)
Council for Exceptional Children (CEC)
International Society for Technology in Education (ISTE)
National Science Teachers Association (NSTA)
National Council of Teachers of English (NCTE)
National Council of Teachers of Mathematics (NCTM)
National Council for the Social Studies (NCSS)

Note: Left margin indicates question number for combined data file, version numbers in which each question or question part (item) appears, and the letter (question part) where that item appears in each version, if different by version. The final page contains a table indicating which question numbers in each version are associated with a particular question number in the combined version.

PART J. YOUR TEACHING PHILOSOPHY

J1. **The following paragraphs describe observations of two teachers' classes, Ms. Hill's and Mr. Jones'. Answer each question below by checking the box under the column that best answers that question for you.**

V3
V4

Ms. Hill was leading her class in an animated way, asking questions that the students could answer quickly; based on the reading they had done the day before. After this review, Ms. Hill taught the class new material, again using simple questions to keep students attentive and listening to what she said.	Mr. Jones' class was also having a discussion, but many of the questions came from the students themselves. Though Mr. Jones could clarify students' questions and suggest where the students could find relevant information, he couldn't really answer most of the questions himself.

	Definitely Ms. Hill's	Tend towards Ms. Hill's	Can't decide	Tend towards Mr. Jones'	Definitely Mr. Jones'
a. Which type of class discussion are you more comfortable having in class?	❑	❑	❑	❑	❑
b. Which type of discussion do you think most students prefer to have?	❑	❑	❑	❑	❑
c. From which type of class discussion do you think students gain more knowledge?	❑	❑	❑	❑	❑
d. From which type of class discussion do you think students gain more useful skills?	❑	❑	❑	❑	❑

J2. ALL **Indicate how much you disagree or agree with each of the following statements about teaching and learning.**

		Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
v2a v3a v4a	a. Teachers know a lot more than students; they shouldn't let students muddle around when they can just explain the answers directly	❑	❑	❑	❑	❑	❑
v2b v3b v4b	b. A quiet classroom is generally needed for effective learning	❑	❑	❑	❑	❑	❑
v1a v3c v4c	c. Students are not ready for "meaningful" learning until they have acquired basic reading and math skills	❑	❑	❑	❑	❑	❑
v1b v3d v4d	d. It is better when the teacher –not the students–decides what activities are to be done	❑	❑	❑	❑	❑	❑
v1e v2e v3e	e. Student projects often result in students learning all sorts of wrong "knowledge"	❑	❑	❑	❑	❑	❑

v1f v2f v3f	f.	Homework is a good setting for having students answer questions posed in their textbooks	❑	❑	❑	❑	❑	❑
v1g v2g v3g v4g	g.	Students will take more initiative to learn when they feel free to move around the room during class	❑	❑	❑	❑	❑	❑
v1h v2h v3h v4h	h.	Students should help establish criteria on which their work will be assessed	❑	❑	❑	❑	❑	❑
v1c v2c v4e	i.	Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly	❑	❑	❑	❑	❑	❑
v1d v2d v4f	j.	How much students learn depends on how much background knowledge they have—that is why teaching facts is so necessary	❑	❑	❑	❑	❑	❑

J3. ALL **Different teachers have described very different teaching philosophies to researchers. For each of the following pairs of statements, check the box that best shows how closely your own beliefs are to each of the statements in a given pair. The closer your beliefs to a particular statement, the closer the box you check.** Please ✔ only one for each set.

a.	"I mainly see my role as a facilitator. I try to provide opportunities and resources for my students to discover or construct concepts for themselves."	❑	❑	❑	❑	❑	"That's all nice, but students really won't learn the subject unless you go over the material in a structured way. It's my job to explain, to show students how to do the work, and to assign specific practice."
b.	"The most important part of instruction is the content of the curriculum. That content is the community's judgment about what children need to be able to know and do."	❑	❑	❑	❑	❑	"The most important part of instruction is that it encourage "sense-making" or thinking among students. Content is secondary."
c.	"It is useful for students to become familiar with many different ideas and skills even if their understanding, for now, is limited. Later, in college, perhaps, they will learn these things in more detail."	❑	❑	❑	❑	❑	"It is better for students to master a few complex ideas and skills well, and to learn what deep understanding is all about, even if the breadth of their knowledge is limited until they are older."
d.	"It is critical for students to become interested in doing academic work—interest and effort are more important than the particular subject-matter they are working on."	❑	❑	❑	❑	❑	"While student motivation is certainly useful, it should not drive what students study. It is more important that students learn the history, science, math and language skills in their textbooks."

e. "It is a good idea to have all sorts of activities going on in the classroom. Some students might produce a scene from a play they read. Others might create a miniature version of the set. It's hard to get the logistics right, but the successes are so much more important than the failures." ❑ ❑ ❑ ❑ ❑ "It's more practical to give the whole class the same assignment, one that has clear directions, and one that can be done in short intervals that match students' attention spans and the daily class schedule."

J4. **Teachers know that different approaches sometimes work for different types of students and that a mix of approaches is often the best. Between the two basic approaches shown, what mix of lesson time do you think is best for each of these types of students?**

V3
V4

	Giving students background factual knowledge and directly teaching concepts			Using active learning approaches like student discussions, projects, and presentations	
	90%	70%	50-50	70%	90%
a. For 5th grade students learning American history	❑	❑	❑	❑	❑
b. For 11th grade students in a college prep science class	❑	❑	❑	❑	❑
c. For 8th grade students who are not doing much work but enough to "get by"	❑	❑	❑	❑	❑
d. For an enthusiastic learner in one of your classes	❑	❑	❑	❑	❑
e. For a slow learning and unmotivated student whom you teach	❑	❑	❑	❑	❑

J5. **Which THREE of the following do you believe are the <u>most important objectives</u> that middle and high school education should have?** Please ✓ the 3 most important objectives.

V3
V4

1. Mastery of content in science, history, algebra, and literature ❑
2. Developing talent in the performing arts or athletics ❑
3. Competence in writing and in oral communication ❑
4. Learning to reason carefully and use evidence well ❑
5. Being able to work well in groups, and understand different views ❑
6. Being interested and able to learn independently ❑
7. Wanting to help others and contribute to the general community ❑
8. Developing skills in using computers to analyze and present ideas ❑

J6. **The following statements are about schooling and social issues. Indicate your agreement or disagreement with each.**

V3
V4

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
a. The American economy will be sufficiently strong during the next two or three decades to provide a place in the working world for people of all skill levels	❑	❑	❑	❑	❑	❑
b. In the 21st century world economy, there won't be nearly enough "blue-collar" and service jobs for the numbers of people who typically graduate from high-school and don't go on to college	❑	❑	❑	❑	❑	❑
c. A good academic education, through college, will provide students the most important skills and knowledge they will need to succeed in work	❑	❑	❑	❑	❑	❑
d. Most high school and college education does not provide what students now need—a capacity to take initiative, to organize work with others, to deal with novel problems, and to use technologies	❑	❑	❑	❑	❑	❑
e. Schools have generally failed to educate most students from lower class backgrounds enough for them to escape the poverty of their origins	❑	❑	❑	❑	❑	❑
f. Good basic reading and mathematics skills and learning the important facts of history and science will enable most students from immigrant and poor families to succeed in school and later life	❑	❑	❑	❑	❑	❑

J7. **How useful are each of the following kinds of assessments for you in judging how well students are learning?**

ALL

	Not Useful	Slightly Useful	Moderately Useful	Very Useful	Essential
a. Short-answer and multiple-choice tests	❑	❑	❑	❑	❑
b. Essay tests	❑	❑	❑	❑	❑
c. Open-ended problems	❑	❑	❑	❑	❑
d. Individual and group projects	❑	❑	❑	❑	❑
e. Standardized test results	❑	❑	❑	❑	❑
f. Student presentations/performances	❑	❑	❑	❑	❑

PART K. YOUR TEACHING PRACTICE IN ONE CLASS

K1. **Circle the grades that you teach.**

ALL

pre-K K 1 2 3 4 5 6 7 8 9 10 11 12

K2. **How many different children or adolescents do you teach during a week in all of your classes combined?**.....

ALL

K3. **Complete the following table about the classes you are teaching now. List each class period you teach on a separate line, even if the classes are in the same subject. If you teach a single self-contained class all day, write "self-contained."** If your teaching assignment changes frequently, use your current responsibilities.

ALL

For each class you teach, write the specific title or subject of the class (e.g., Algebra II; Reading-Lang. Arts), and check (✔) the achievement or ability levels of the students in that class relative to all children or adolescents of that age. Check ALL achievement levels that apply to at least 5 students. By "very low" or "very high," we mean more than a year below or above average students in that grade.

CLASS TITLE (OR "SELF-CONTAINED")	ACHIEVEMENT OR ABILITY LEVELS (Check ALL that apply to at least 5 students)				
	Very Low	Below Average	Average	Above Average	Very High
1_____	❑	❑	❑	❑	❑
2_____	❑	❑	❑	❑	❑
3_____	❑	❑	❑	❑	❑
4_____	❑	❑	❑	❑	❑
5_____	❑	❑	❑	❑	❑

K4. **In which of your classes (i.e., specific period of your teaching day), are you most satisfied with your teaching—where you accomplish your teaching goals most often?**

ALL Select only one. If you teach only one class, circle "1".

a. CIRCLE the LINE # for this class from the previous table (K3): 1 2 3 4 5

b. In this class, what are the students' grade levels? _____

c. Number of students enrolled _____

d. Number of LEP (limited English proficient) _____

e. Number of mainstreamed special education students _____

f. Hours per week you teach this class _____

Please refer to this one class when answering the remaining questions in this section. If this is a self-contained class, answer the next **two** questions about the subject with which you usually start the day.

K5. **How would you characterize the number of topics (i.e., themes, units, or chapters in a textbook) that you cover in this class? Would you say it was...**

ALL

1. A very large number ❑
2. A large number, but covered in some depth ❑
3. A moderate number covered in depth ❑
4. A small number covered in great depth ❑

K6. **When you introduced the current unit in this class, which of the following approaches did you use during the first two or three lessons?** If you haven't completed lesson three, answer

ALL about the previous unit you completed.

In Introducing the Current Unit:	Didn't Use and Rarely Do	Didn't Use but Often Do	Used This Time
a. I offered the class a reward for doing well on the unit	❑	❑	❑
b. I had students do introductory drills on skills or facts	❑	❑	❑
c. I had students discuss the topic among themselves in small groups	❑	❑	❑
d. I asked students to make conjectures about what they will learn or discover during the unit	❑	❑	❑
e. I raised questions about the unit that I did not know the answers to	❑	❑	❑

K7. **Over the last 5 hours that you taught this class, roughly how many minutes did students spend in each of the following activities?**

V3
V4

	Under 30 mins	30-60 mins	1-1/4 to 2 hours	Over 2 hours
a. Teacher led a whole-class discussion (students listened and answered questions)	❑	❑	❑	❑
b. Students led a discussion or gave a presentation	❑	❑	❑	❑
c. Students worked on their own on assignments at their desks	❑	❑	❑	❑
d. Students worked together in small groups to complete an assignment as a team	❑	❑	❑	❑

K8. **About how often do students in this class take part in the following types of activities?**

ALL

	Never	Some-times	1-3 times per Month	1-3 times per Week	Almost Everyday
a. Work individually answering questions in the textbook or worksheets	❑	❑	❑	❑	❑
b. Do hands-on/laboratory activities	❑	❑	❑	❑	❑
c. Work on projects that take a week or more	❑	❑	❑	❑	❑
d. Write in a journal	❑	❑	❑	❑	❑
e. Suggest or help plan classroom activities or topics	❑	❑	❑	❑	❑
f. Work in small groups to come up with a joint solution or approach to a problem or task	❑	❑	❑	❑	❑
g. Work on problems for which there is no obvious method of solution	❑	❑	❑	❑	❑
h. Write an essay in which they are expected to explain their thinking or reasoning at some length	❑	❑	❑	❑	❑

K9. **When you ask students questions in this class, how often are you trying to accomplish the following goals?**

ALL

	Never	Some-times	Often	Very often	Always
a. See if students know the correct answer	❑	❑	❑	❑	❑
b. See if students have done the homework	❑	❑	❑	❑	❑
c. Elicit students' ideas and opinions	❑	❑	❑	❑	❑

d. Get students to justify and explain their reasoning	❑	❑	❑	❑	❑
e. Have students relate what they are working on to their own experiences	❑	❑	❑	❑	❑

K10. **Teachers sometimes discuss with students why the topics, skills, or facts they are studying are important or interesting. Indicate how often you use each reason in this class.**

V3
V4

	Never say	Seldom say	Sometimes say	Often say	Very Often say
a. How it will help them to get a good grade	❑	❑	❑	❑	❑
b. How important it is for learning later units in the course	❑	❑	❑	❑	❑
c. How it will help them get a good job or into college	❑	❑	❑	❑	❑
d. How useful it is in real life outside of school	❑	❑	❑	❑	❑
e. How significant it is for understanding another idea, which you then describe at some length	❑	❑	❑	❑	❑

K11. **How often do you give the following kinds of assignments to this class?**

ALL

	Never	Some-times	1-3 times per Month	Once a Week or More
a. Students hold a debate and argue for a particular point of view which may not be their own	❑	❑	❑	❑
b. Students have to design their own problems to solve	❑	❑	❑	❑
c. Students decide on their own procedures for solving a complex problem and then discuss among themselves their different procedures and results	❑	❑	❑	❑
d. Students write an essay or hold a serious discussion assessing their own work on a paper or project--what they did well, how they could have improved it, etc.	❑	❑	❑	❑
e. Assignments where students have to represent the same idea or relationship in more than one way--e.g., in math, by a table and a graph; in English, by a poem and an essay	❑	❑	❑	❑
f. Students make a product that will be used by someone else	❑	❑	❑	❑
g. Students demonstrate their work to an audience including people other than from the school or their family	❑	❑	❑	❑
h. Tasks where there is no indisputably correct answer--where truth is complex and perhaps impossible to know	❑	❑	❑	❑

PART L: YOUR USE OF COMPUTERS

In this section, please answer in reference to the same class as in the previous section.

L0. **Please check the one description of computer use that most closely applies to you.**

ALL

1. I (or my students) use computers in the same class described in the previous section ☐ Continue at L1
2. I use computers in other classes, but not in that particular class ☐ Skip to L8
3. I use computers only to prepare for classes or in other professional activities ☐ Skip to L9
4. I don't currently use computers either with my students or for professional activities but have done so in the past ☐ Skip to L10
5. I have never used computers in teaching or for any professional activities ☐ Skip to L18

L1. **On how many days since September has a typical student in this particular class used a computer while you were teaching their class?** ✔ one choice.

ALL

1. 1-5 times ☐
2. 6-10 times ☐
3. 11-20 times ☐
4. 21-40 (weekly) ☐
5. 41+ (twice/week) ☐

L2. **Typically, how many students operate any one computer at one time during this class?** ✔ the most common arrangement, or ✔ two if two are equally common.

ALL

1. One student ☐
2. In pairs (2) ☐
3. In groups of 3-4 ☐
4. Other (Please specify) ☐

L3. **Where do students use computers during this class and how many computers are available in each room?** ✔ the most common arrangement, or ✔ two if two are equally common.

ALL

		# of Computers
1. Classroom	☐	
2. Computer Lab	☐	
3. Media Center	☐	
4. Other (Please specify)	☐	

(# of Computers: V3 & V4 only. See question L7 for V1 & V2.)

L4. **In your opinion, what are the best computer programs students in this class have used? Indicate the titles of these programs (including Internet access programs) and what your students used the software to do.** (Emphasize those that you believe are most useful to most students.)

V 3
V 4

"BEST" SOFTWARE TITLES USED IN THIS CLASS	WHAT STUDENTS USED THE SOFTWARE TO DO
1 _____	1 _____
2 _____	2 _____
3 _____	3 _____

L5A. Which of the following are among the objectives you have for student computer use?

ALL

	✔ ALL that apply
1. Mastering skills just taught	☐
2. Remediation of skills not learned well	☐
3. Expressing themselves in writing	☐
4. Communicating electronically with other people	☐
5. Finding out about ideas and information	☐
6. Analyzing information	☐
7. Presenting information to an audience	☐
8. Improving computer skills	☐
9. Learning to work collaboratively	☐
10. Learning to work independently	☐
11. Other (describe): _____	☐

L5B. **Which 3 objectives from the list above have been your most important ones?** (Write 3 numbers from above list.)

ALL

a _____,

b _____ and

c _____

L6. **Whether or not students use computers during class time, some students may use computers to do work for this class at other times. How many students in this class have done work for this class using computers in each of these settings <u>on at least several occasions</u>?**

V1
V2

	None or few	1/4	1/2	3/4	All students
a. At other times while at school (lunch, before or after school, etc.)	❑	❑	❑	❑	❑
b. At home (or outside of school)	❑	❑	❑	❑	❑

L7. **How many computers are available for your students in each of these locations, and which type of computer do they use?** Note: IBM and similar PCs are listed below as "Win/DOS," standing for Windows and DOS operating systems.

V1
V2

Answer only for locations where students use computers for **this class**. Write "NA" if location not used.

	NUMBER OF COMPUTERS PRESENT	WHICH TYPE OF COMPUTER DO STUDENTS USE MOST? (Check the predominant type of computer in that room)			
		Mac	Win/DOS	Apple II	Other
a. My own classroom	_____	❑	❑	❑	❑
b. School library or media center	_____	❑	❑	❑	❑
c. Computer lab	_____	❑	❑	❑	❑

L8. **The remaining questions refer to ANY of the classes that you teach. For each of the following types of software, please indicate for how many lessons your students have used that type of software this year in ANY of your classes.**

ALL

	No lessons	1-2 lessons	3-9 lessons	10+ lessons
a. Games for practicing skills	❑	❑	❑	❑
b. Simulations or exploratory environments	❑	❑	❑	❑
c. Encyclopedias and other references on CD-ROM	❑	❑	❑	❑
d. Word processing	❑	❑	❑	❑
e. Software for making presentations (e.g., PowerPoint)	❑	❑	❑	❑
f. Graphics-oriented printing (e.g., Print Shop)	❑	❑	❑	❑
g. Spreadsheets or database programs (creating files or adding data)	❑	❑	❑	❑
h. Hyperstudio, HyperCard, or other multimedia authoring environment	❑	❑	❑	❑
i. World Wide Web browser	❑	❑	❑	❑
j. Electronic mail	❑	❑	❑	❑

L9. ALL **In which of these ways do you use computers in preparing for teaching your classes or in other professional activities?**

I use computers to:	Do not use	Occasionally	Weekly	More often
a. Record or calculate student grades	❑	❑	❑	❑
b. Make handouts for students	❑	❑	❑	❑
c. Correspond with parents	❑	❑	❑	❑
d. Write lesson plans or related notes	❑	❑	❑	❑
e. Get information or pictures from the Internet for use in lessons	❑	❑	❑	❑
f. Use camcorders, digital cameras, or scanners to prepare for class	❑	❑	❑	❑
g. Exchange computer files with other teachers	❑	❑	❑	❑
h. Post student work, suggestions for resources, or ideas and opinions on the World Wide Web	❑	❑	❑	❑

L10. ALL **How many years ago, if at all, did you first use computers in the following ways?**

	Never	In the last 2 years	3-5 years ago	6-9 years ago	10+ years ago
a. For assigning computer tasks to students in your classes	❑	❑	❑	❑	❑
b. For your own work (e.g., grading, handouts, transparencies, etc.)	❑	❑	❑	❑	❑
c. For other activities (e.g., personal e-mail, word processing, games)	❑	❑	❑	❑	❑

L11. **In what setting did you first become reasonably comfortable with using computers?**

ALL

✔only one

1. While I was a student in high school or earlier ❑
2. While in college or getting first teaching credential ❑
3. While working in another job, outside of teaching ❑
4. During my first 3 years in teaching ❑
5. More recently during my teaching career ❑
6. Other (describe): _____ ❑
7. I am still not "reasonably familiar and comfortable with using computers" ❑

L12. ALL **How much experience have you had with each of the following types of computers?**

	None	A little	Moderate amount	Very experienced	Expert level
a. Windows/DOS PC (IBM style)	❑	❑	❑	❑	❑
b. Macintosh or Power Macintosh	❑	❑	❑	❑	❑
c. Apple II series	❑	❑	❑	❑	❑

L13. ALL **For how many years, if at all, have you had a computer at your home? A modem?** If you don't have a computer or a modem at home, please write "0".

a. Computer at home _____ Years

b. Modem at home _____ Years

A central aspect of this study is learning how teachers' use of computers has changed over the past five years.

L14. V1 V3 V4 **How important were computers in your teaching in each of the past five academic years?**

	Did not use computers	Minor Importance	Moderately Important	Very Important
a. This Year (1997-1998)	❑	❑	❑	❑
b. Last Year (1996-1997)	❑	❑	❑	❑
c. 1995-1996	❑	❑	❑	❑
d. 1994-1995	❑	❑	❑	❑
e. 1993-1994	❑	❑	❑	❑

L15. V1 V2 **For each year that you indicated computers were <u>moderately</u> or <u>very important</u> in your teaching, what was the most valuable computer software that you or your students used and why was it valuable for you? How did you or your students use it? What objectives did it help you reach?**
If no computer software or application was worthwhile for you that year, write "none."

	MOST VALUABLE SOFTWARE	WHY THAT SOFTWARE WAS VALUABLE THAT YEAR
a. This Year		
b. Last Year		

c. 1995-1996

d. 1994-1995

e. 1993-1994

L16. **Over the past five years, have your students ever used computers in the following ways?**

ALL

	No	Partly	Yes
a. Collect data from people, newspapers, or the environment, enter the results into the computer, and present conclusions using graphic software	❑	❑	❑
b. Collaborate with classes in other schools and compile information for a project directed by teachers or by outside scientists	❑	❑	❑
c. Write a story, then illustrate it with scanned images or digitized pictures, record sounds for the story, and make a multimedia presentation using Hyperstudio	❑	❑	❑
d. Become expert about a topic and publish text and pictures on the Web	❑	❑	❑
e. Write a computer program to control a robotic device that they built	❑	❑	❑

L17. **Compared to five years ago, are you using computers more frequently or less frequently in these ways?**

V 2
V 3
V 4

	Less frequently now	Stayed the same	More frequently now	MUCH more now
a. Trying out new software or technologies	❑	❑	❑	❑
b. Using computers for class preparation (e.g., handouts, overheads)	❑	❑	❑	❑
c. Using computers for non-work activities	❑	❑	❑	❑
d. Assigning students to use computers	❑	❑	❑	❑
e. Suggesting that students use computers in their projects	❑	❑	❑	❑

L18. **We would like you to assess your own current skills related to using computers.**

ALL

I know how to

	No	Somewhat	Yes
a. display the directory of a disk	❑	❑	❑
b. copy files from one disk to another	❑	❑	❑
c. create a new database and establish fields and screen layouts	❑	❑	❑
d. imbed graphics into a word-processor document	❑	❑	❑
e. prepare a slide show using presentation software	❑	❑	❑
f. use a World Wide Web search engine	❑	❑	❑
g. develop a multimedia document using Hyperstudio or similar authoring software	❑	❑	❑

L19. ALL **How valuable do you think the following equipment and software might be for your teaching, whether or not you are currently using it?**

	Not needed	Some value	Valuable	Essential	Don't know
a. A telephone in your classroom	❑	❑	❑	❑	❑
b. At least 6 computers in your classroom	❑	❑	❑	❑	❑
c. Teacher's computer station with electronic mail access	❑	❑	❑	❑	❑
d. World Wide Web access in your classroom	❑	❑	❑	❑	❑
e. A full page scanner for digitizing photos and graphics	❑	❑	❑	❑	❑
f. Video camera (camcorder)	❑	❑	❑	❑	❑
g. Encyclopedias and other reference works on CD-ROM	❑	❑	❑	❑	❑
h. Presentation software (e.g., PowerPoint)	❑	❑	❑	❑	❑
i. Hyperstudio, HyperCard, other multimedia authoring program	❑	❑	❑	❑	❑

L20. ALL **Which of these are advantages of using computers in teaching?** If you haven't had enough experience with computers to have an opinion, check the "don't know" box.

		Not true, not an advantage	Somewhat true, a mild advantage	True, a modest advantage	True, a strong advantage	Don't know
v1a v3c v4c	a. Students create better-looking products than they could do with just writing and other traditional media	❑	❑	❑	❑	❑
v2a v3a v4a	b. Computers provide a welcome break for students from more routine learning activities	❑	❑	❑	❑	❑
v2b v3b v4b	c. Students help one another more while doing computer work	❑	❑	❑	❑	❑
v1b v3d v4d	d. Students take more initiative outside of class time--doing extra research or polishing their work	❑	❑	❑	❑	❑
v1e v2e v3e	e. Students' writing <u>quality</u> is better when they use word processing	❑	❑	❑	❑	❑
v1c v2c v4e	f. Students work harder at their assignments when they use computers	❑	❑	❑	❑	❑
v1d v2d v4f	g. Students are more willing to do second drafts	❑	❑	❑	❑	❑

v1f v2f v3f	h.	'Average' students are communicating and producing in ways only 'gifted' ones did before	❑	❑	❑	❑	❑

L21. Which of these are disadvantages of using computers in teaching?

ALL

			Not true, not a disadvantage	Somewhat true, a mild disadvantage	True, a modest disadvantage	True, a strong disadvantage	Don't Know
v1a v2a v3a v4a	a.	Computers are too unpredictable—they "crash," or the software doesn't work right	❑	❑	❑	❑	❑
v2b v3b v4b	b.	Computers are hard to figure out how to use	❑	❑	❑	❑	❑
v1b v3c v4c	c.	Many students use computers in order to avoid doing more important school work	❑	❑	❑	❑	❑
v1e v2e v3d	d.	Many students are not careful enough with this expensive equipment	❑	❑	❑	❑	❑
v1f v2f v3e	e.	It is difficult to integrate computer activities into most of my regular lesson plans	❑	❑	❑	❑	❑
v1g v3f v4f	f.	Often too many students need my help at the same time	❑	❑	❑	❑	❑
v2g v3g v4g	g.	Students often get so wound up, I can't get them to settle down afterwards	❑	❑	❑	❑	❑
v1c v2c v4d	h.	A teacher has to give up too much instructional responsibility to the computer software--I feel I'm not really "teaching"	❑	❑	❑	❑	❑
v1d v2d v4e	i.	Students can cheat easier--copying work and turning it in as their own	❑	❑	❑	❑	❑

PART M: GENERAL TEACHING EXPERIENCES

M1. **For how many years have you been a full-time K-12 teacher and for what grade levels?**

ALL

a Years of full time teaching _____

b Grade levels ever taught (lowest to highest): _____ to _____

M2. **At which types of schools have you taught?**

ALL

✔ ALL that apply

1 In a public school ❑
2 In a parochial (church-related) school ❑
3 In a private (independent) school ❑

M3. **In the past three years, which of these experiences have you had as a teacher?** If none, ✔ 7. "I had none of those experiences."

ALL

		✔ ALL that apply
1	Informally mentor another teacher for most of a year	❑
2	Formally be assigned to mentor a teacher for most of a year	❑
3	Give a workshop or conference talk for at least 25 teachers	❑
4	Give workshops for teachers on at least 5 different occasions	❑
5	Teach a college-level course for credit	❑
6	Publish an article in a magazine or journal for professional educators	❑
7	I had none of those experiences	❑

M4A. **Compared to three years ago, how much do you employ the following practices?**

V1
V2

			Less now than 3 years ago	Same as before	More now	MUCH more now	Never did
v2a	a	Plan a lesson using principles of direct instruction (review, teach, guided practice, individual practice)	❑	❑	❑	❑	❑
v2b	b	Have many activities going on in the room at the same time	❑	❑	❑	❑	❑
v2c	c	Use the textbook as my primary guide through units	❑	❑	❑	❑	❑
v2d	d	Let student interest partly influence the topics in the lesson	❑	❑	❑	❑	❑
v1a	e	Closely monitor and supervise students while they work	❑	❑	❑	❑	❑
v1b	f	Give students a reward for doing well on a big assignment	❑	❑	❑	❑	❑
v1c	g	Evaluate students through their products instead of tests	❑	❑	❑	❑	❑
v1d	h	Allow myself to be taught by students	❑	❑	❑	❑	❑

M4B. How much of a role have computers played in the changes to student assignments you reported above?

V1
V2

✓ only one

1. No role at all (computers were not related to those changes) ❑
2. A minor role (in most cases) ❑
3. A substantial role in many cases ❑
4. A major role in most of those change ❑
5. Not applicable/No changes ❑

M5A. Compared to 3 years ago, how much do you give the following types of assignments?

V1
V2

		Less Now than 3 years ago	Same as Before	More Now	MUCH More Now	Never Did
v1a	a. Have students teach or help other students	❑	❑	❑	❑	❑
v1b	b. Have students explore a topic on their own, without direction	❑	❑	❑	❑	❑
v1c	c. Have students review and revise their own work	❑	❑	❑	❑	❑
v1d	d. Have students make predictions and investigate them	❑	❑	❑	❑	❑
v2a	e. Have students work on long projects	❑	❑	❑	❑	❑
v2b	f. Have students answer questions in their textbooks	❑	❑	❑	❑	❑
v2c	g. Have students work in groups	❑	❑	❑	❑	❑
v2d	h. Have students write a page or more on a single subject	❑	❑	❑	❑	❑

M5B. How much of a role have computers played in the changes to student assignments you reported above?

V1
V2

✓ only one

1. No role at all (computers were not related to those changes) ❑
2. A minor role (in most cases) ❑
3. A substantial role in many cases ❑
4. A major role in most of those changes ❑
5. Not applicable/No changes ❑

M6A. Compared to three years ago, how much do you:

V1
V2

		Less Now than 3 years ago	Same as Before	More Now	MUCH More Now	Never Did
v1&2a	a. Work with other teachers on curriculum planning?	❑	❑	❑	❑	❑
v1&2b	b. Talk with other teachers about teaching strategies?	❑	❑	❑	❑	❑
v1&2c	c. Spend time preparing lessons?	❑	❑	❑	❑	❑
v1&2d	d. Reflect deeply about what good teaching is?	❑	❑	❑	❑	❑

M6B. **How much of a role have computers played in the changes you reported in the previous question?**

V1
V2

✓ only one

Computers played

1. No role at all (were not related to those changes) ❑
2. A minor role (in most cases) ❑
3. A substantial role in many cases ❑
4. A major role in most of those changes ❑
5. Not applicable/No changes ❑

M7. **How have computers affected the way you do or think about the following?**

V1
V2

	Not affected by computers	Small change because of computers	Moderate change because of computers	Big change because of computers
a. The way you organize space in your classroom	❑	❑	❑	❑
b. The way you break up your class period into activities	❑	❑	❑	❑
c. Your beliefs about curriculum priorities	❑	❑	❑	❑
d. Your goals in teaching	❑	❑	❑	❑

M8. **Considering all of the ways that you have changed your teaching practice over the past three years, how big of a role did each of the following reasons play?**

V1
V2

	Not a reason	Minor reason	Moderate reason	Major reason
a. Changes in the subjects or grade levels you teach	❑	❑	❑	❑
b. Changes in district policies and expectations	❑	❑	❑	❑
c. Changes in the climate or emphasis at your school	❑	❑	❑	❑
d. Changes in the abilities or prior achievement of the students you teach	❑	❑	❑	❑
e. Staff development and workshop experiences you have had	❑	❑	❑	❑
f. Discussions you have had with colleagues at your school	❑	❑	❑	❑
g. Discussions you have had with other people	❑	❑	❑	❑
h. Changes in the main goals you have for students	❑	❑	❑	❑
i. Changes in your understanding of how people learn or understand things	❑	❑	❑	❑
j. Changes in the textbooks you are given to use	❑	❑	❑	❑
k. Opportunities and experiences you have had with computers or other technologies	❑	❑	❑	❑

PART N: YOUR WORK ENVIRONMENT

	N1. ALL How often do you have the following types of interactions with other teachers at school?	Never/ Seldom	Several per month	1-3 times per week	Almost daily
v2a v3a v4a	a. Discussions about how to teach a particular concept [(to a class) - version 2]	❑	❑	❑	❑
v1a v3b v4b	b. Discussions about ideas for student or group projects	❑	❑	❑	❑
v1b v2b v3c v4c	c. Discussions about computers, software, or the Internet	❑	❑	❑	❑
v1d v2d v3d	d. Informal discussions of personal matters, unrelated to teaching	❑	❑	❑	❑
v1c v2c v4d	e. Discussions where we exchange different views about an issue within our common subject-area (e.g., science)	❑	❑	❑	❑
v1e v2e v3e v4e	f. Visits to another teacher's classroom to observe their teaching	❑	❑	❑	❑
v1f v2f v3f v4f	g. Informal observations of MY classroom by another teacher	❑	❑	❑	❑

	N2. ALL Since September, roughly how often have you had contact with teachers at OTHER schools through the following means?	Not this year	1-2 times	3-5 times	More often
	a. A workshop, class, or conference with teachers from different schools	❑	❑	❑	❑
	b. A committee meeting with teachers from different schools	❑	❑	❑	❑
	c. Electronic mail with teachers from other places	❑	❑	❑	❑

N3. ALL **The following statements describe teachers' work environments. Please indicate how much each statement agrees or disagrees with your own work situation.**

		Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
v1c v3a	a. Discussion of school goals and how to achieve them is a regular part of our faculty meetings	❑	❑	❑	❑	❑	❑
v3b v4a	b. Other teachers encourage me to try out new ideas	❑	❑	❑	❑	❑	❑
v1d v3c	c. The people who give me the best ideas for improving my teaching also tend to know a lot about using computers	❑	❑	❑	❑	❑	❑
v3d v4d	d. My principal's values and philosophy of education are similar to my own	❑	❑	❑	❑	❑	❑
v1e v2e v3e v4e	e. Teachers who successfully introduce a major innovation in their teaching are given public recognition among other teachers	❑	❑	❑	❑	❑	❑
v1g v3f	f. New ideas presented at in-services are discussed afterwards by teachers in this school	❑	❑	❑	❑	❑	❑
v3g v4g	g. Each time there is a staff development meeting, it covers a <u>different</u> topic	❑	❑	❑	❑	❑	❑
v1a v2a	h. Most teachers here share my beliefs about what the central goals of the school should be	❑	❑	❑	❑	❑	❑
v1b v2b	i. Teachers in this school are continually learning and seeking new ideas	❑	❑	❑	❑	❑	❑
v2c v4b	j. It is common for us to share samples of student work	❑	❑	❑	❑	❑	❑
v2d v4c	k. If most teachers feel that another teacher is not doing a good job, they will press that person to improve	❑	❑	❑	❑	❑	❑
v1f v2f	l. Teachers play an important role in defining staff development activities	❑	❑	❑	❑	❑	❑
v2g v4f	m. Major staff development activities are followed by support to help teachers implement new practices	❑	❑	❑	❑	❑	❑

N4. ALL **Approximately, how many scheduled school or district staff development sessions have you participated in since June 1997?**

a. # of scheduled staff-development days or half-days (count half-day as 0.5) _____

b. # of staff development meetings before or after school or evenings _____

c. # of sessions on non-work days (Saturdays, summer) _____

N5. ALL **In the formal staff development activities you have attended since June 1997, which of the following topics were discussed?**

	Topic not discussed	Topic mentioned	Central topic
a. Content to teach your students	❑	❑	❑
b. New knowledge about your subject-matter (for your own education)	❑	❑	❑
c. Improving how well students work in groups or peer discussions	❑	❑	❑
d. The mechanics of using computer technology and software	❑	❑	❑
e. Integrating computers into instructional activities in your subject area	❑	❑	❑
f. How to use the Internet or other on-line activities	❑	❑	❑
g. How to enable students to create multimedia presentations	❑	❑	❑
h. Connecting skills instruction with real-world applications	❑	❑	❑
i. Connecting content with student interests or with students' prior beliefs	❑	❑	❑
j. Improving students' critical thinking or problem-solving	❑	❑	❑
k. Improving students' meta-cognition—their ability to monitor how well they are learning something	❑	❑	❑
l. Improving students' abilities to write or to review other students' writing	❑	❑	❑

N6. ALL **What kinds of technology resources has the school provided for your use?**

	✓ ALL that apply
1. A telephone in your room	❑
2. Easy access to photocopying with reasonable limits regarding cost-free use	❑
3. Easy access to a fax machine	❑
4. A desktop computer for your own use while at school	❑
5. A laptop computer for using both at work and at home	❑
6. A computer printer in your room or nearby	❑
7. Access to computers in the teachers' lounge or department office	❑
8. Access to electronic mail from your classroom, lounge, or office	❑